PB84-158161

Simulation Model for Watershed
Management Planning. Volume 2
Model User Manual

Colorado State Univ., Fort Collins

Prepared for

Environmental Research Lab., Athens, GA

Feb 84

U.S. Department of Commerce
National Technical Information Service
NTIS

EPA-600/3-84-028b
February 1984

PB84-158161

SIMULATION MODEL FOR WATERSHED MANAGEMENT PLANNING
Volume II: Model User Manual

by

Daryl B. Simons
Ruh-Ming Li
Kenneth G. Eggert
Jimmy Nan-Hsuing Ho
William T. Fullerton
V. M. Ponce
Nguyen Duong
Civil Engineering Department
Engineering Research Center
Colorado State University
Fort Collins, Colorado 80523

Grant No. 805131-01

Project Officer

Lee A. Mulkey
Technology Development and Applications Branch
Environmental Research Laboratory
Athens, Georgia 30613

ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
ATHENS, GEORGIA 30613

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/3-84-028b	2.	3. RECIPIENT'S ACCESSION NO. PB84 158161
4. TITLE AND SUBTITLE Simulation Model for Watershed Management Planning, Volume II: Model User Manual		5. REPORT DATE February 1984
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Daryl B. Simons, Ruh-Ming Li, Kenneth G. Eggert, Richard Miskimins, William T. Fullerton, Jimmy Nan-Hsing Ho, V.M. Ponce and Nguyen Duong		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Civil Engineering Department, Engineering Research Center, Colorado State University, Fort Collins CO 80523		10. PROGRAM ELEMENT NO. CARB1A
		11. CONTRACT/GRANT NO. 805131
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency--Athens GA, Office of Research and Development, Environmental Research Laboratory, Athens GA 30613		13. TYPE OF REPORT AND PERIOD COVERED Final, 4/77-10/80
		14. SPONSORING AGENCY CODE EPA/600/01

15. SUPPLEMENTARY NOTES
Volume I: Model Theory and Formulation

16. ABSTRACT

This report provides a user manual for the hydrologic, nonpoint source pollution simulation of the generalized planning model for evaluating forest and farming management alternatives. The manual contains an explanation of application of specific code and indicates changes that should be considered when applying the simulation to different watersheds. Two example applications of the model are included to illustrate model sensitivity to management alternatives. A timber harvest example composes the undisturbed watershed with clear-cut logging with balloon, high lead, and tractor transport. A grazing activity example compares rotation and heavy continuous grazing alternatives. The manual appendices contain all program listings and job control language for the CDC CYBER 172. Input and output descriptions also are provided. Flow charts and a detailed description of model information flow are presented.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS (This Report) UNCLASSIFIED	21. NO. OF PAGES 407
	20. SECURITY CLASS (This page) UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (9-73)

DISCLAIMER

Although the research described in this report has been funded wholly or in part by the United States Environmental Protection Agency through Grant No. 805131-01 to Colorado State University, it has not been subjected to the Agency's required peer and policy review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

FOREWORD

As environmental controls become more costly to implement and the penalties of judgment errors become more severe, environmental quality management requires more efficient analytical tools based on greater knowledge of the environmental phenomena to be managed. As part of this Laboratory's research on the occurrence, movement, transformation, impact, and control of environmental contaminants, the Technology Development and Applications Branch develops management or engineering tools to help pollution control officials achieve water quality goals.

Evaluation of nonpoint source pollution problems requires an understanding of the behavioral response of an ecosystem to the impacts of land use activities on individual components of that ecosystem. By analyzing basic ecosystem processes and impacts of land use activities on specific factors governing production and transport of nonpoint source pollution, it is possible to predict cause-effect relationships between these activities and water quality. To facilitate these predictions, a simulation model for evaluation of alternative agricultural and silvicultural practices as a function of both environmental and management parameters was developed.

William T. Donaldson
Acting Director
Environmental Research Laboratory
Athens, Georgia

ABSTRACT

This report provides a user manual for the hydrologic, nonpoint source pollution simulation of the generalized planning model for evaluating forest and farming management alternatives. The manual contains an explanation of application of specific code and indicates changes that should be considered when applying the simulation to other watersheds. Two example applications of the model are included to illustrate model sensitivity to management alternatives. A timber harvest example conposes the undisturbed watershed with clear-cut logging with balloon, high lead, and tractor transport. A grazing activity example compares rotation and heavy continuous grazing alternatives.

The manual appendices contain all program listings and job control language for the CDC CYBER 172. Input and output descriptions also are provided. Flow charts and a detailed description of model information flow are presented.

This report was submitted in fulfillment of Grant No. R805131-01 by Colorado State University under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period April 10, 1977, to October 31, 1980, and work was completed as of October 31, 1980.

TABLE OF CONTENTS

Section		Page
	Foreword	iii
	Abstract	iv
	List of Figures	vi
	List of Tables	vii
	Acknowledgment	viii
1	INTRODUCTION	1
2	IMPLEMENTATION OF MODEL	3
	INTRODUCTION	3
	HYDROL	3
	MULT	16
	NUTRINT	29
3	FOREST MANAGEMENT EXAMPLE	33
	INTRODUCTION	33
	PARAMETERS INSENSITIVE TO MANAGEMENT	33
	INITIAL CONDITIONS	46
	TIMBER HARVEST EXAMPLE	46
	GRAZING ACTIVITY EXAMPLE	49
	INTERFACE WITH GOAL PROGRAMMING	53
	REFERENCES	57
	APPENDIX A--INPUT DESCRIPTIONS	59
	APPENDIX B--MODEL STRUCTURE	131
	APPENDIX C--ANNOTATED SUBMIT FILE IN CDC JOB CONTROL LANGUAGE	146
	APPENDIX D--LISTING OF PROGRAMS	168
	APPENDIX E--SAMPLE OUTPUT FOR PROGRAMS FOR UNDISTURBED RESPONSE	327
	APPENDIX F--FLOW CHARTS	352

LIST OF FIGURES

Figure		Page
1a	Leaf area index for Scots pine	8
1b	$F(A_I)$ for Figure 1a	8
1c	$g(A_I)$ for Figure 1b	8
2	Soil-plant flux schematic	11
3	Circuit diagram of Figure 2 and first Δ-Y transformation	12
4	Second Δ-Y transformation	15
5	Geometric representation of 2-plane subwatershed	20
6	Subdivision of complex watershed	23
7	Schematic representation of watershed in Figure 6	24
8	Sample computational sequences	27
9	Schematic of example watershed	34
10	Grain size distribution for forest soil	37
11	Grain size distribution for channel bed	39
12	Definition sketch for triangular channel	41
13	Timber harvest alternatives: Storm of May 28, 1972	50
14	Timber harvest alternatives: Storm of June 5, 1972	51
15	Grazing activity alternatives: Storm of May 28, 1972	54
16	Grazing activity alternatives: Storm of June 5, 1972	55
B-1	Generalized planning model	B-5
B-2	Water budget and flux model	B-6
B-3	Water and sediment routing	B-7

LIST OF TABLES

Table		Page
1	Resistance and Resistance Parameter Definitions	13
2	Sample Format for CONxxxx	29
3	F09xxxx for Sequence Illustrated in Figure 8a	30
4	Sequencing for MULT and Form of Input File MLIxxxx	35
5	Soil Data for Management Example	35
6	Soil Moisture Tension Data for Management Example	36
7	Interception Volumes	39
8	Channel Geometry Parameters	43
9	Effects of Log Transport System on Forest Soils	46
10	Increases in Bulk Density	47
11	Parameter Changes Reflecting Timber Harvest	48
12	Summary of Yields for Timber Harvest Alternatives	52
13	Parameter Changes Reflecting Grazing Activity	52
14	Summary of Yields for Grazing Activity Alternatives	53

ACKNOWLEDGMENTS

The authors wish to thank the production staff at the Engineering Research Center for their efforts in preparing this report. Annette Ward, Tamra McFall, and Janna Fullerton checked, edited and prepared the report for publication. Lee Mulkey was the Project Officer for this study from the Environmental Protection Agency, Athens, Georgia, Laboratory. The assistance of all these individuals is greatly appreciated with special thanks to the technical typing personnel.

SECTION 1

INTRODUCTION

This volume is a user's manual for the system of programs described in Simulation Model for Watershed Management Planning, Volume I: Model Theory and Formulation (Simons et al., 1984) referred to in this report as "Volume I." The basic theoretical background of the simulation appears in the above volume and will not be repeated here. This volume is intended to familiarize the user with the program system, necessary file manipulation and data required to use the simulation. It will also serve to document the planning model simulation and provide an example illustrating the model's sensitivity to management alternatives.

The body of this report will consist of a discussion of model implementation; that is, code specific to a given application that may require alteration if the simulation is used in situations significantly different than the coniferous forest example provided. Following the discussion of model implementation are examples of model sensitivity to varying timber harvest methods and grazing activities.

The bulk of this user's manual is found in the appendices. Appendix A describes the input files to all programs. The formats, file structure and input variable definitions should allow the users to adapt the data files to their needs. Appendix B is a repetition of Section 2 of Volume I describing the flow of information through the model. The execution sequence provided should allow the user to run the model efficiently. Appendix C provides the annotated job control language file that runs the simulation on the CDC CYBER 172 computer at Colorado State University. These control statements are specific to the CDC machine; however, they serve to illustrate the necessary file manipulation and should ease translation to another operating

system. Appendix D contains the program code. By using Volume I in conjunction with the comment statements included in the program texts, the calculation sequence of the model should be understandable. Appendix E contains sample model outputs, and Appendix F provides flow charts for the more complex routines of the model.

This volume is intended to be used with Volume I, and together both volumes provide the program documentation.

SECTION 2

IMPLEMENTATION OF MODEL

INTRODUCTION

The basic structure and theory of the model were discussed in Volume I. Formulation of all subroutines is essentially as described in that report; however, some of the code requires more explanation. The theory of this program may be implemented in several ways as pointed out for PROSPER by Goldstein, Mankin and Luxmoore (1974). Applications of the program to various watersheds may require some internal modification of the program to fit the situation. As required in the criteria for model development listed in Volume I, on the whole, application of the model to different watersheds is accomplished largely by respecifying input parameters. However, some functions programmed into the model may require modification for the watershed of interest. Such modifications could be accomplished by designing the program to be sufficiently general to allow the restructuring to be performed by changing various inputs. It was decided, however, that in this case internal modification of the model to the particular watershed was more time efficient. The technique of adapting the model to a particular situation is illustrated by the current program version for hypothetical forest management examples.

HYDROL

In its present form the simulation should be sufficiently general for a wider range of application. However, the form of the internal funtions described below may require alternation if the proposed application differs radically. In part, the implementation of HYDROL consists of various internal empirical relationships and a plant and soil water flux electrical analog. Assumptions made in order to calculate water fluxes will be enumerated first.

Heat Transfer by Convection

The rate of transfer of heat energy by convection A from the evapotranspiration surface is given by

$$A = [\sigma C_p \rho (T_1 - T_2)]/r_a \tag{1}$$

where C_p is the specific heat of air at constant pressure, ρ is the density of air, T_1 is the temperature of the evapotranspiration (ET) surface, T_2 is the ambient air temperature, r_a is the resistance to the transfer of sensible heat from the evapotranspiration surface to the atmosphere. All of these parameters have been defined in Volume I with the exception of σ, the ratio of convection area to evapotranspiration area. For this implementation, σ is given by

$$\sigma = 1 + \frac{A_I}{A_{Imax}} \tag{2}$$

where A_I is the current leaf area index and A_{Imax} is the maximum value of A_I.

Convection occurs throughout the canopy. Since the evapotranspiration surface is a combination of soil surface, litter surface and leaf area, the evapotranspiration surface does not reflect the vertical structure of the canopy. Therefore, σ is given this simple form to allow for greater convection than would be possible from a simple plane and relates convection area to canopy growth. This expression appears in subroutine PROSPR as the definition of Fortran variable SIGMA. This function appears in the version of PROSPER used in the study by Swift et al. (1975).

Implementation Specific to Vegetation Type

The resistance to vapor flux away from the evapotranspiration surface r_x is a function of ET surface potential ψ_x and is assumed to have the form

$$r_x = R_x + (r_c - R_x)\, e^{h_1(\psi_c - \psi_x)} \qquad |\psi_x| < |\psi_c|$$
$$r_x = r_c \qquad |\psi_x| \geq |\psi_c| \tag{3}$$

where R_x is analogous to the stomatal resistance at full hydration, ψ_c is the critical water surface potential representing fully closed stomata, r_c is analogous to the cuticle resistance that dominates under stomatal closure at $\psi_x = \psi_c$, and h_1 is an empirical constant. The form of the equation for r_x is presented by Goldstein, Mankin and Luxmoore (1974) as representing functional relationships encountered in their review of plant-water relationships. If more exact information is available to the user, this expression may be changed. It is found in subroutine EVAL, in the definition of Fortran variable RRR.

The parameters of Eq. 3 are also evaluated internally. Stomatal resistance at full hydration, R_x is given by

$$R_x = 6 - \left(\frac{A_I}{A_{Imax}}\right)\left(5 - \frac{2(T-T_{on})}{(T_{off}-T_{on})}\right) \tag{4}$$

where T is the Julian day number, T_{on} is the Julian day the canopy has emerged 50%, the T_{off} is the Julian day the canopy has fallen below 50% emergence. This expression is found in subroutine PROSPR. In the current version the cuticle resistance is $r_c = 380\ \frac{\text{days}}{\text{cm}}$. This value is found in subroutine EVAL. Similarly, the critical potential ψ_c is defined to be -15 bars in subroutine EVAL. These values are functions of the canopy species and may be adjusted accordingly. Parameter h_1 is currently defined to be -0.5. This parameter may be obtained by calibration as evapotranspiration data are available.

It should be noted that the expression for r_x, the resistance to vapor flux from the evapotranspiration surface is related to canopy growth through the expression for R_x. This functional relationship can account for

observations that the number of open stomata varies during the year and that minimum stomatal resistance per unit area varies with leaf area. Therefore, if changes to this function are made, these variations may need to be considered.

Swift et al. (1975) modified the energy flux equation originally implemented by Goldstein, Mankin and Luxmoore (1974) to account for leaf area being much greater than ground surface area. However, the leaf area index is not directly used since not all of the canopy is equally effective in evapotranspiration at any given time. An effective leaf area function $f(A_I)$ defining Fortran variable FAC appears in subroutine EVAP. This variable has the form

$$f(A_I) = \frac{A_I}{1 + \frac{A_I}{3}} \tag{5}$$

In addition, $f(A_I)$ is used in the energy balance calculation of evapotranspiration flux given by

$$R_N = (f(A_I) + 1)\, L_v F_v + (\sigma f(A_I) + 1)\, A + G \tag{6}$$

where R_N is the net incoming solar radiation, L_v is the latent heat of vaporization of water, A is the convective heat flow, F_v is the vapor flux, and G is the daily change in soil heat storage. The functional form of $f(A_I)$ was selected for experimental data obtained at the Coweeta Hydrological Laboratory and is discussed in Swift et al. (1975). If such data are available in the area to be modeled, the formulation could be changed.

The electrical analog representation discussed below assumes that plant transpiration characteristics may be lumped into a single resistance to water flux for each watershed plane. Therefore, active roots, stems and leaves are assumed to be homogeneously distributed across the plane. This assumption is probably most valid under the condition of a closed canopy. However, for

management activities such as crop growth in agricultural watersheds, timber replacement and regrowth, or under natural conditions of low canopy cover a closed canopy cannot be assumed. Since number of transpiration paths per unit ground area is reduced for low values of leaf area index, the resistance to transpiration water flux should increase during these periods. Swift et al. (1975) presented a function of the form

$$g(A_I) = \frac{k\ A_I^{\ 2}}{(A_1^{\ 2} + A_I^{\ 2})} \tag{7}$$

where A_1 and k are calibrated parameters, to accomplish the increase in resistance. The transpiration resistances are therefore divided by $g(A_I)$. The functions $f(A_I)$ and $g(A_I)$ are plotted for a given leaf area index function in Figure 1. The function $g(A_I)$ appears in subroutine PROSPR defining the Fortran variable FAC. Here, $g(A_I)$ is as defined above with values of k and A_1 of 0.422 and 1.95 respectively. These values were obtained by Swift et al. (1975) using Coweeta for calibration. It should be noted that the same FORTRAN variable FAC is used in program HYDROL in different subroutines for functions $f(A_I)$ and $g(A_I)$; however, FAC is not passed out of the particular subroutines, and as described, performs a different purpose in each.

Electrical Water Flux Analog

The electrical analog used to model plant and water fluxes is represented by expressions appearing in subroutines EVAL and PROSPR and remains unchanged from the formulation presented by Goldstein, Mankin and Luxmoore (1974). The expressions are written for the flux of water to the ET surface in terms of the potential of the soil layers and the unknown potential of the ET surface. As discussed Volume I, the flux away from the ET to the atmosphere is calculated using a modified Penman approach. The flux away from the surface

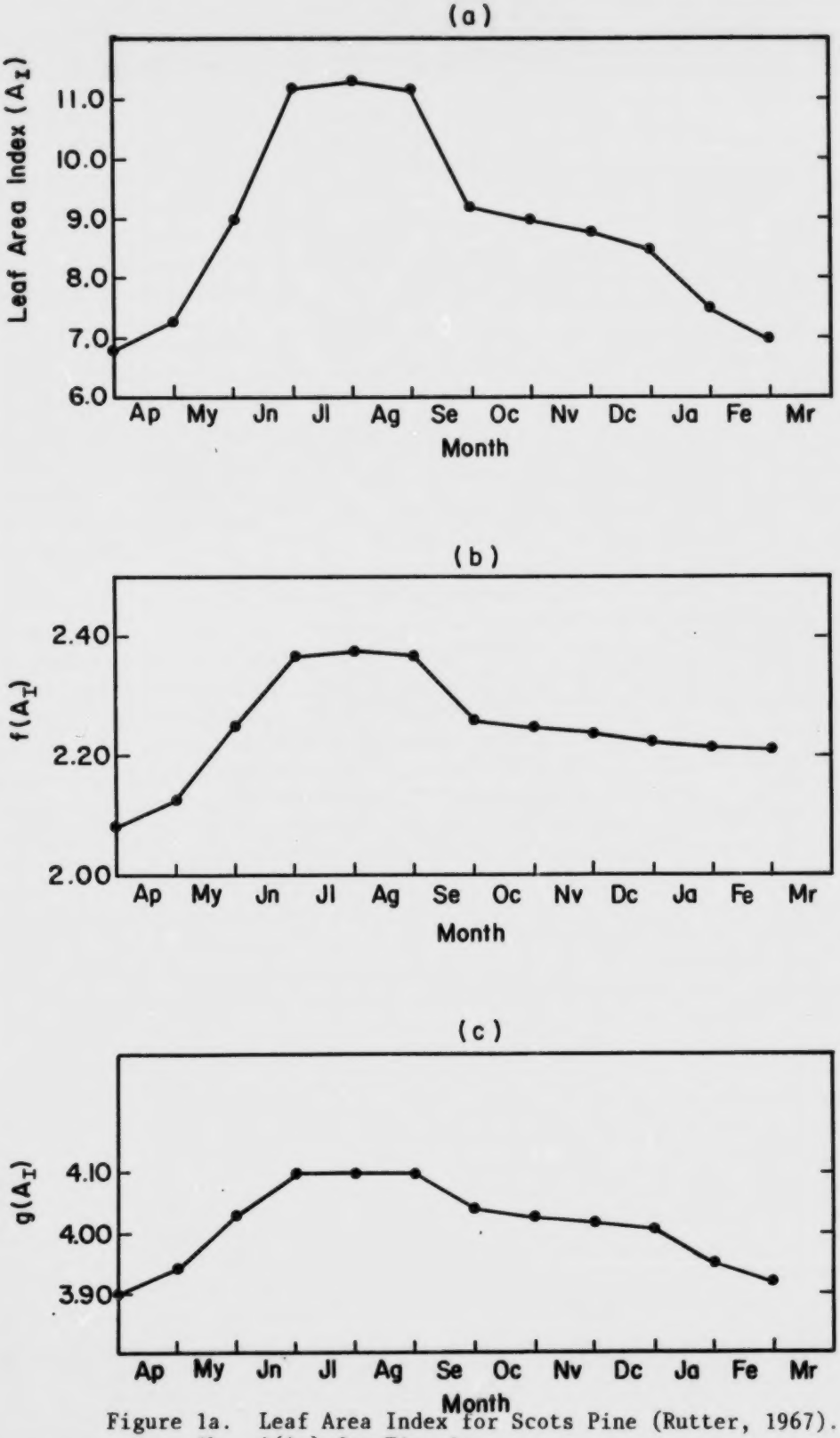


Figure 1a. Leaf Area Index for Scots Pine (Rutter, 1967).
1b. $A(A_I)$ for Fig. 1a.
1c. $g(A_I)$ for Fig. 1a.

is also a function of the ET surface potential through the expression for resistance to vapor flux from the ET surface. If the flux to the surface is called $H(\psi_x)$ and the flux away from the surface is called $F_v(\psi_x)$, and the flux to the surface is assumed to be equal to the flux away from the surface, then

$$F_v(\psi_x) = H(\psi_x) \ . \tag{8}$$

The flux away from the surface was shown to be given by

$$F_v(\psi_x) = \frac{\left[\left(\frac{(R_N - G)\delta}{\sigma C_p \rho}\right)\left(\frac{\rho^*_{w_2} - \rho_{w_2}}{r_a}\right)\right]}{\left[\left(\frac{r_a + r_x(Y)}{r_a}\right) + \left(\frac{L_v \ \delta}{\sigma C_p \rho}\right)\right]} \tag{9}$$

where $\delta = \frac{\rho^*_{w_1} - \rho^*_{w_2}}{T_1 - T_2}$, ρ^*_w is the saturation vapor density, ρ_w is the vapor density, T is temperature, r_a is the resistance to vapor flux due to diffusion resistance, and subscripts 1 and 2 refer to the ET surface and atmosphere respectively.

$H(\psi_x)$ represents a function of ψ_x derived by circuit analysis of the representative soil-plant electrical analog. An example of the function $H(\psi_x)$ will be derived below for the current model implementation. From the functional form of $H(\psi_x)$, and $F_v(\psi_x)$, it is clear that Eq. 8 is a nonlinear expression for ψ_x. In addition, it is functionally desirable to separate the expressions for vapor flux away from the ET surface and water flow to the surface so that their forms may be altered to fit the user's purpose. Therefore, Eq. 8 is solved numerically by subroutine SOLVO1, a linear fractional iteration scheme. Subroutine SOLVO1 seeks to find a zero of the function $F(\psi_x)$ where

$$F(\psi_x) = H(\psi_x) - F_v(\psi_x) \tag{10}$$

In subroutine EVAL, $F(\psi_x)$ is Fortran variable P and ψ_x is Y. The numerical scheme iterates ψ_x until $F(\psi_x) < \varepsilon$ where ε is given the value of 10^{-5} in subroutine SOLV01.

The PROSPER model on which HYDROL is partially based provides for up to five soil layers. The current model formulation assumes that there are five layers but the four lowest layers are assumed to have the same properties due to a lack of data. As stated earlier, the form of $H(\psi_x)$ is dependent on the electrical analog used to represent the soil-plant system. The current form is based on the representation shown in Figure 2. The resistance definitions for Figure 2 appear in Table 1. Here the plant roots are assumed to be distributed only in the top two soil layers of a five layer soil column. The schematic of Figure 2 may be redrawn as shown in Figure 3a with resistance values as defined below and in Table 1 and seen in subroutines PROSPR, EVAL EVAP and SUBEV. In Table 1 below, d_i is the thickness of soil layer i, K_i is hydraulic conductivity of soil layer i, f_i is the fraction of roots in soil layer i, A_{r_i} is the cross-sectional area of roots in layer i. The The conductivity of roots in layer i is assumed to be linearly related to the soil conductivity by

$$K_{r_i} = C_1 K_i \tag{11}$$

where C_1 is an empirically derived constant having the value of 10^4 in the current implementation. For convenience the resistances in Figures 2, 3 and 4 correspond directly to the Fortran variable.

The resistance to water flow between soil layers is represented by $RSBL_i$ in Figure 2. To simplify the resistance expressions the above resistances are regrouped as illustrated in Figure 3a. Resistance equivalences between Figure 2 and Figure 3a are as follows:

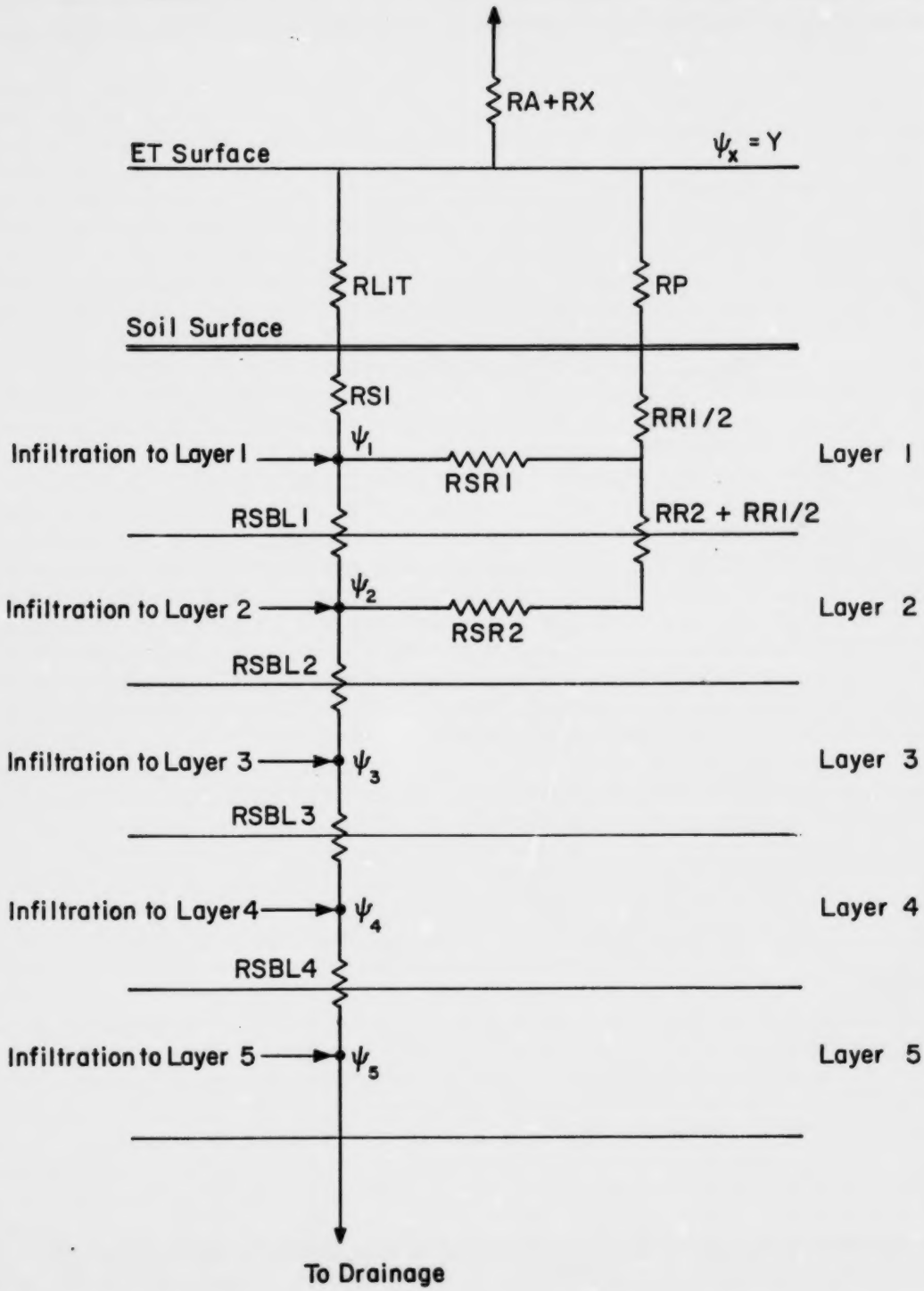


Figure 2. Soil-plant flux schematic.

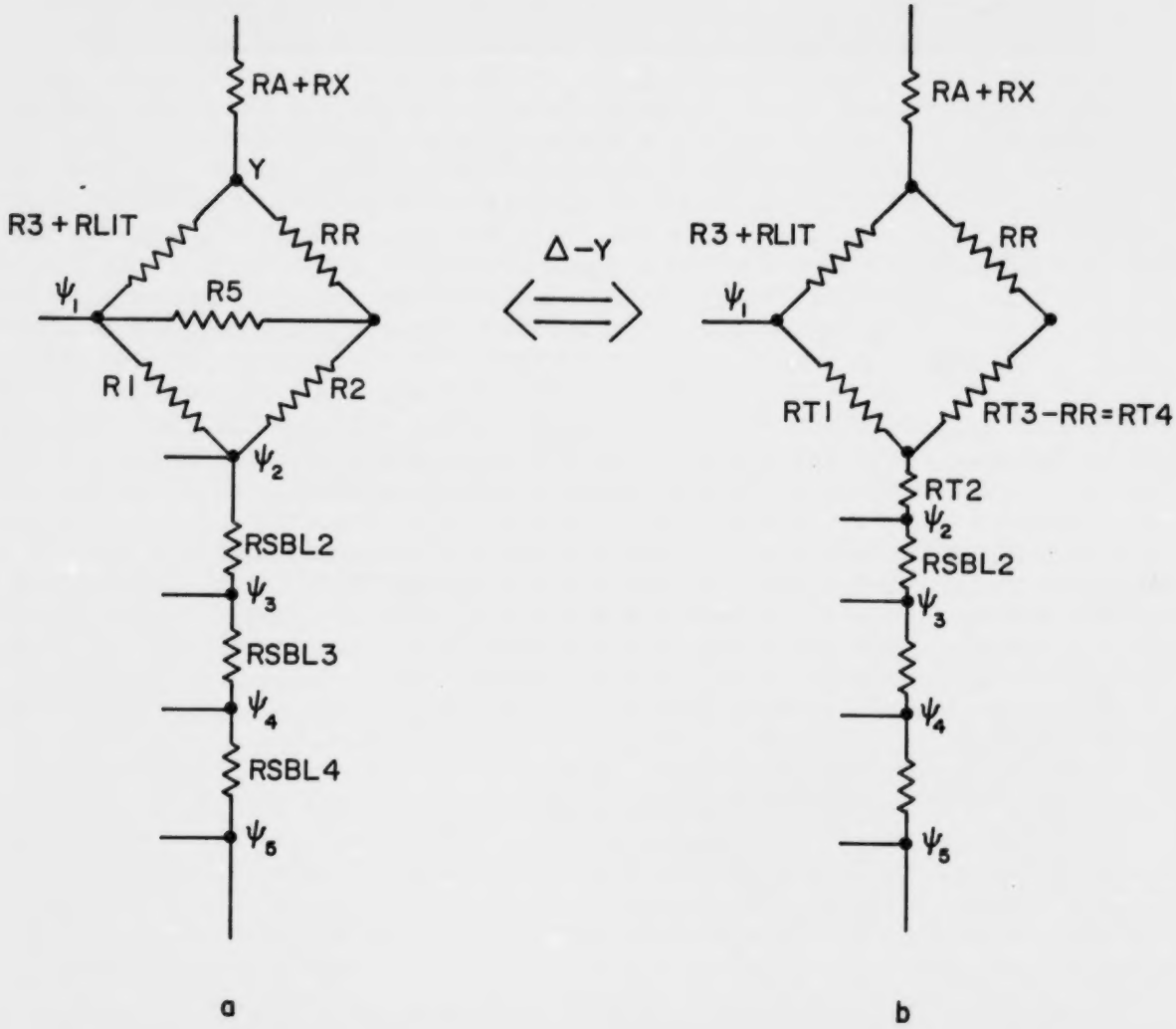


Figure 3. Circuit diagram of Figure 2 and first Δ-Y transformation.

TABLE 1. Resistance Definitions for Figure 2.

Resistance in Volume I	Resistance in Figure 2	Verbal Description	Defining Expression or Resistance Value in Current Implementation
r_ℓ	RLIT	resistance of litter layer	200,000
r_{s1}	RS1	resistance of soil layer 1	$\frac{d_1}{2\ K_1}$
r_{s2}	RS2	resistance of soil layer 2	$\frac{d_2}{2\ K_2}$
r_{r1}	RR1	resistance of roots in layer 1	$\frac{d_1}{2\ A_{r1}K_{r1}}$
r_{r2}	RR2	resistance of roots in layer 2	$\frac{d_2}{2\ A_{r2}K_{r2}}$
r_{sr1}	RSR1	resistance to soil water uptake by roots in layer 1	$\frac{d_1A_{r1}}{f_1A_IK_1}$
r_{sr2}	RSR2	resistance to soil water uptake by roots in layer 2	$\frac{d_2A_{r2}}{f_2A_IK_2}$
r_p	RP	above ground plant resistance	5,000

$$
\begin{aligned}
R1 &= RSBL1 \\
R2 &= RSR2 + (RR2 + RR1/2)\ g(A_I) \\
R3 &= RS1 \\
R4 &= RP + RR1/2 \\
R5 &= (RSR1)\ g(A_I)
\end{aligned}
\tag{12}
$$

The numerical value of 200,000 for r_ℓ was obtained by calibration by Goldstein, Mankin and Luxmoore (1974). The value of 5000 appearing in this expression for the above ground plant resistance r_p was obtained from Cowan (1965). Both values represent possible calibration parameters for ET flux.

A Δ-Y transformation is performed on the lower Δ of Figure 3a to produce the equivalent circuit of Figure 3b. The Δ-Y transform gives an equivalent circuit element with resistances given by

$$RT1 = \frac{R1\ R5}{R1 + R5 + R1}$$

$$RT2 = \frac{R1\ R2}{R1 + R5 + R2} \tag{13}$$

and

$$RT4 \equiv RT3 - RR = \frac{R5\ R2}{R1 + R5 + R2} \tag{14}$$

or

$$RT3 = \frac{R5\ R2}{R1 + R5 + R2} + RR \tag{15}$$

RT1, RT2 and RT3 appear in subroutine EVAL. Noting that the loop of the circuit of Figure 3b may be redrawn as Figure 4a, another Δ-Y transformation may be applied again to give the final equivalent circuit shown in Figure 4b. Equivalent resistances are given by

$$RRA = \frac{RT3 \cdot RT1}{RT1 + RT3 + R3 + RLIT} + RT2 \tag{16}$$

$$RRB = \frac{(R3 + RLIT) \cdot RT3}{RT1 + RT3 + R3 + RLIT} \tag{17}$$

$$RRC = \frac{(R3 + RLIT) \cdot RT1}{RT1 + RT3 + R3 + RLIT} \quad . \tag{18}$$

Again RRA, RRB and RRC appear in subroutine EVAL. Knowing potentials ψ_1 and ψ_2 from the previous calculation, the flux to the ET surface, $H(\psi_x)$ may be expressed in terms of ET surface potential Y by Kirchhoff's current law applied at node A (Figure 4). Allowing ψ_A to represent the potential at node A, and using the convention the flux away from the node is negative,

$$H(\psi_x) = \frac{\psi_A - \psi_1}{RRC} + \frac{\psi_A - \psi_2}{RRA} \tag{19}$$

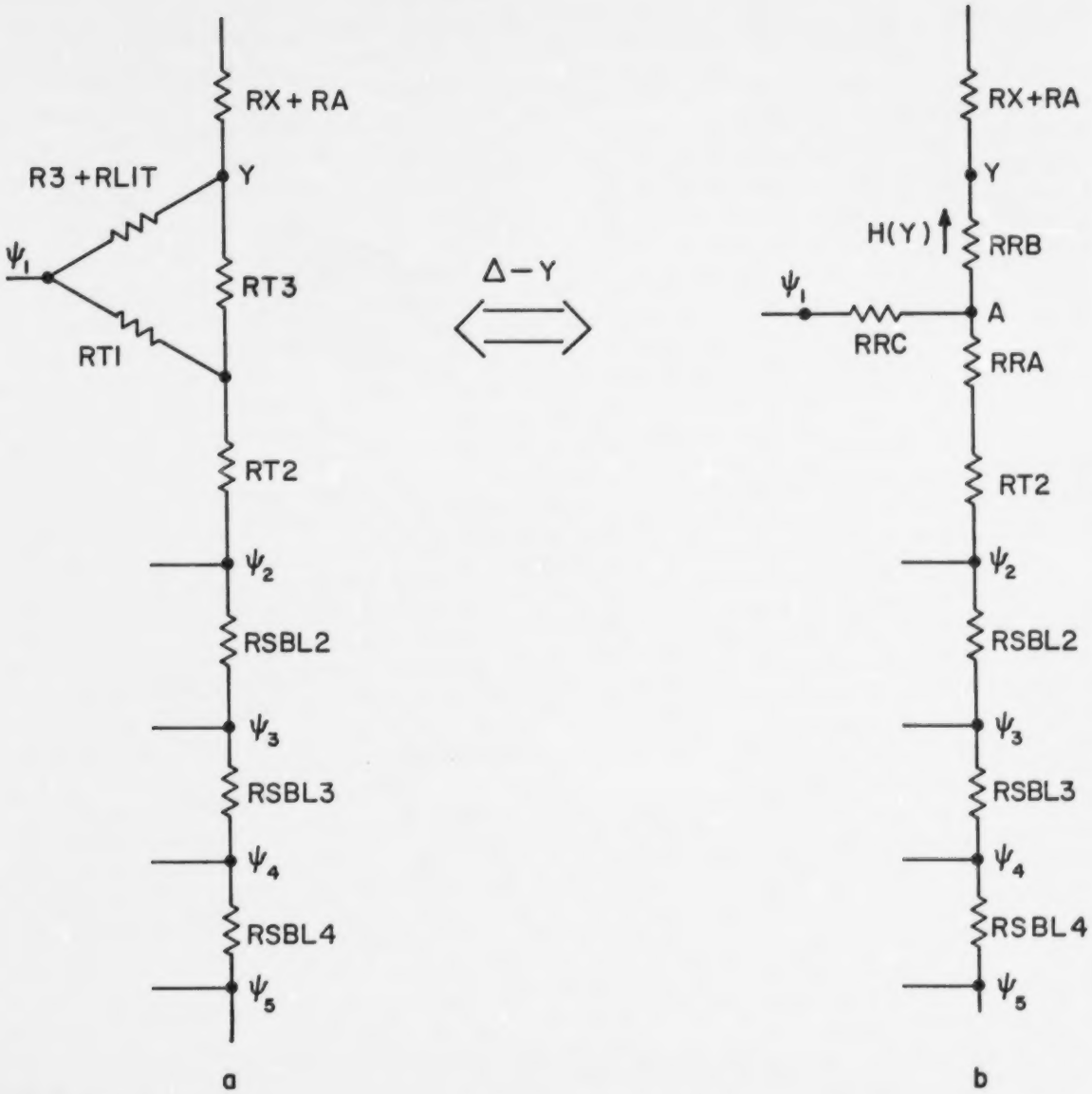


Figure 4. Second Δ-Y transformation.

However, from Ohms law,

$$H(\psi_x) = \frac{\psi_x - \psi_A}{RRB} \tag{20}$$

Therefore,

$$H(\psi_x) = \frac{(RRA + RRC)\psi_x - RRA\ \psi_1 - RRC\ \psi_2}{RRC\ RRA + (RRA + RRC)RRB} \tag{21}$$

or

$$H(\psi_x) = \frac{\psi_x - \frac{RRA}{D}\ \psi_1 - \frac{RRC}{D}\ \psi_2}{\frac{RRA\ RRC}{D} + RRB} \tag{22}$$

where $D = RRA + RRC$. This is the form of $H(\psi_x)$ found in subroutines EVAL and SUBEV. This derivation is presented to indicate how the form of $H(\psi_x)$ depends on the circuit representation and may be used as a guide if a different representation such as 3 or more soil layers of differing properties is desired.

Finally, the subroutine TEWAT provides the stream water temperature as a function of ambient air temperature. This function,

$$T_w = .96875\ T_a - \frac{20.3125}{9.0} \tag{23}$$

is based on a linear regression of data appearing in TVA 1972. The current high country coniferous forest watershed is assumed to have cool water as reflected by Eq. 22. This function should be changed to reflect conditions in streams below the watershed.

SNOWMELT

The Leaf and Brink (1973a) snowmelt model was designed to produce daily runoff water yields. This type runoff description is inadequate for prediction of the water hydrographs required for simulation of nonpoint source pollution transport. A means for transforming the melt water volume into a snowmelt hyetograph is required. Since the melt occurs in response to the

input of solar energy, it seems reasonable to approximate the snowmelt hyetograph by distributing the melt over the sunshine period using the hourly insolation divided by the total daily insolation as a weighting function. Since hourly measurements of insolation at the snowpack are not usually available it is assumed that the corresponding ratio of hourly extraterrestrial to total extraterrestrial radiation will suffice. This insolation weighted meltwater runoff function is subjected to infiltration of the saturated hydraulic conductivity, and the resulting excess runoff is treated by the routing models in the same manner as the excess rainfall.

MULT and MCHNL

Programs MULT and MCHNL route water and sediment through a large complex watershed by combining the responses for the subunits that make up the watershed, and then linking together the responses of the subunits. Individual characteristics of separate areas in the watershed can therefore be maintained, resulting in a more accurate simulation. The basic subunits of the subdivided watershed are planes, subwatersheds, channels and connections. The definition of each type of unit is discussed in Section 4 of Volume I. In order to properly execute the model the user must decompose the watershed into a representation composed of the above subunit types. The following can be used as a guide in determining the segmentation of a watershed into a system of the four basic types:

1. Delineate the major channels of the basin and the boundaries of the drainage areas for each channel.
2. Determine which portions of the watershed, if any, are to be treated as connection units.
3. Separate the channel into units with end boundaries either at the junction of two major channels or at the upstream end of the channels delineated in step 1.

4. If necessary, further subdivide the channel units to be consistent with the assumption that the channel geometry (i.e., slope, width, shape) is approximately constant over the specified reach.
5. Consider the lateral inputs to the channel units as plane units and the remaining upland areas as subwatershed units.
6. After dividing the basin into plane, subwatershed and channel units, determine the geometry of each unit.
7. Draw a schematic diagram of the watershed with all the units identified.
8. From the schematic diagram determine the ordering of the units for the input files.

Most of these steps can be carried out with only the aid of a topographic map and a set of channel cross sections. If homogeneity of characteristics such as soil type or canopy cover are to be maintained, the subdivisions made in step 4 may require further break down. This decision requires additional information such as soil surveys, aerial photographs and on-site inspections.

Determination of Geometry

The parameters used to characterize the geometry of the channel units are channel length and slope, and two cross sectional geometry relationships. The cross sectional geometry is specified by two power relationships

$$P = a_1 A^{b_1} \tag{24}$$

and

$$T = a_2 A^{b_2} \quad . \tag{25}$$

when P is the wetted perimeter, T is the stream top width, and A is the cross sectional flow area.

These coefficients a_1, b_1, a_2 and b_2 are determined by applying least squares regression techniques to the channel cross sectional data. If several cross sections are available in the channel, then the average of the coefficients is used.

The channel length is measured directly from the topographic map. The slope is then determined by reading the elevation of the channel from the topographic map at both its upstream and downstream points and, in the usual fashion, dividing the difference in elevation by the length of the channel. In some cases the contour intervals may not be small enough to determine an accurate elevation at the ends of the channel, and a further survey of the channel may be required. This additional information may be obtained when the cross sectional data is collected.

The subwatershed unit geometry is represented by an "open-book" approximation which consists of two planes and one channel. This transformation involves a degree of subjectivity, but is constrained by the necessity that the projected surface area of the approximation must equal the area of the original subwatershed. This procedure is illustrated in Figure 5 and described below. It is assumed that a topographic map is being used as the basic data source.

The first step in determining the subwatershed geometry is to obtain the length of the channel. The channel length is defined as the distance over which the flow of water is likely to behave as channel flow. The length is determined by following the indicated channel which will appear as a "V" in the topographic contours uphill from the downstream end until the contours smooth out indicating overland flow to be a better approximation. The determination of the point where the contours smooth out is a source of subjectivity in the method.

Once channel length has been determined, remaining dimensions are obtained as follows:

1. The channel is extended normal to the topographic contours uphill to the watershed divide (Line E in Figure 5a).

2. Now that the watershed has been subdivided by the channel and extended channel, areas on each side of the channel (A_1 and A_2 in Figure 5a) are measured by suitable means.

3. Once the areas are determined, average overland flow lengths for each plane (L_1 and L_2 in Figure 5b) are obtained by dividing the appropriate area by the channel length, L_c. That is,

$$L_1 = \frac{A_1}{L_c}$$

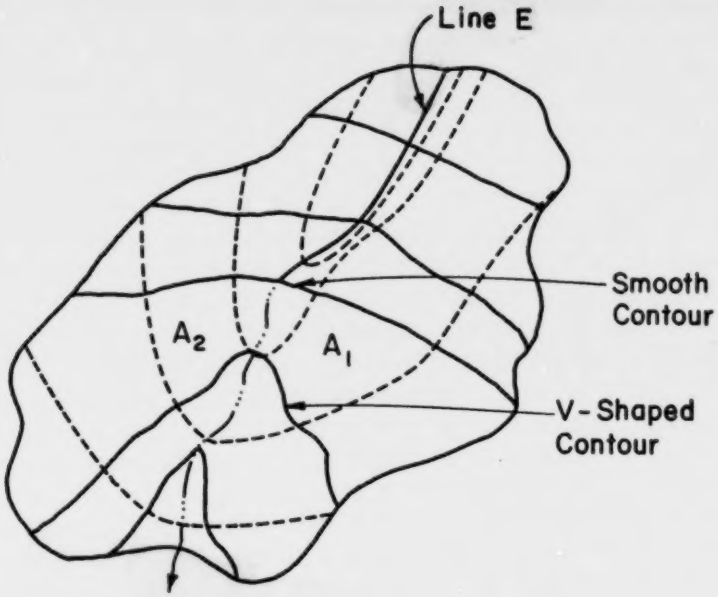
and (26)

$$L_2 = \frac{A_2}{L_c}$$

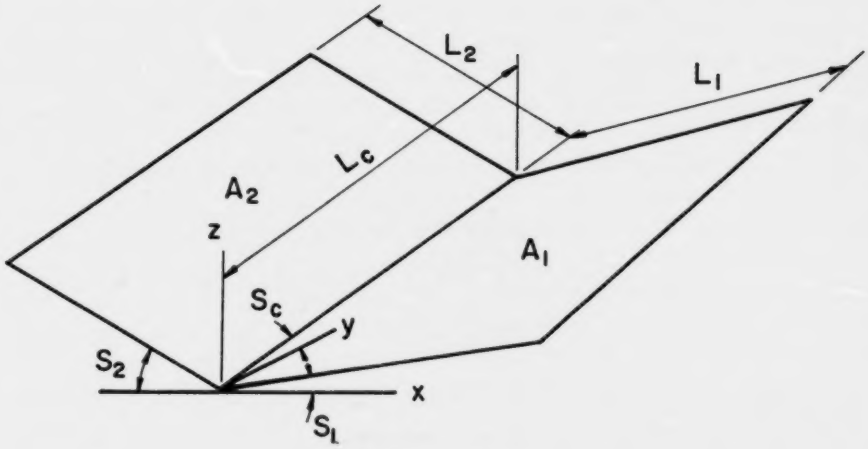
With the watershed dimensions calculated, the next step is determination of the slopes. Channel slope is typically determined by dividing the difference in elevation between the two contour lines intersecting the channel that are farthest apart by the channel length between those contours. The slope of each plane should be a representative average of the slopes on the appropriate side of the channel. This average or weighted mean is obtained as follows:

1. At regular intervals along the channel flow lines normal to the channel are extended uphill toward the watershed boundary. Care must be taken to insure those lines are perpendicular to the topographic contours. These lines represent flow paths for overland flow and are shown as dashed lines in Figure 5a.

2. Slopes of each of these lines are determined in the same manner as the channel slope.



(a) Original Watershed Topographic Map



(b) Wooding Plane Representation

Figure 5. Geometric Representation of 2-Plane Subwatershed.

3. Having calculated the slopes of each line and measured the lines respective lengths, the weighted mean slope is calculated in the usual manner, in this case for plane 1:

$$\bar{S}_i = \frac{\sum_{i=1}^{n} S_{1_i} L_{1_i}}{\sum_{i=1}^{n} L_{1_i}} \tag{27}$$

where S_{1_i} is the slope of the ith line on plane 1 and L_{1_i} is the length of the ith line. The mean slope of plane 2 is obtained in the same manner. The final geometry is shown in Figure 5b.

The user has the option of determining cross sectional geometry parameters a_1 and b_1 for the subwatershed channel in the same manner as the main channel discussed earlier, or he may use a swale flow assumption. Swale flow assumes the channel is formed by the intersection of the planes. The side slopes are identical to the slopes of the planes forming the channel if the assumption of swale flow is used, the program automatically calculates the required parameters a_1, b_1 by equations 87 and 88 found in Volume I. Note that the parameters a_2 and b_2 are not used in the subwatershed channel simulation.

A plane unit occurs when there is land directly contributing lateral inflow to a main channel unit. The geometry of the plane unit is determined in a manner similar to the plane portions of a subwatershed unit. However, in this case the length of the channel is clearly defined by the length of the channel unit bordering it and does not involve interpretation by the user. The length of the channel bordering the plane is divided into the plane area to determine the plane length. The plane unit slope is determined as described earlier for a plane within a subwatershed unit.

A connection unit has no geometry associated with it. It is completely described by known water and sediment hydrographs.

Computational Ordering

The final step in the data preparation process is the ordering of computation. This involves arranging all the collected physical parameters used in approximating physical processes in the subunits in a logical order such that the natural flow pattern of water and sediment is maintained when the units are linked together. The first step is to construct a schematic diagram of the subdivided watershed, so that a clearer picture of the interconnection of the units may be seen. Figure 6 shows a map depicting the subdivision of a complex watershed. A schematic representation of the same watershed is presented in Figure 7. With the schematic diagram the flow sequence can easily be seen, and in this way the interdependence of subunits is determined.

There are a few basic rules which must be followed in arranging the sequencing of units. They are listed below.

1. Gravity controls the system; and therefore, all upstream and/or lateral inputs to a given channel unit must be calculated before the response of that channel unit can be calculated. In other words, the sequence must follow a natural upstream to downstream flow pattern.
2. Once a channel branch has been started, the response of the entire branch down to its confluence with another branch must be calculated before proceeding to calculate any responses on other branches.
3. When there is a confluence, all channel branches flowing in at that point must be calculated before proceeding to calculate responses further downstream or on another portion of the watershed.

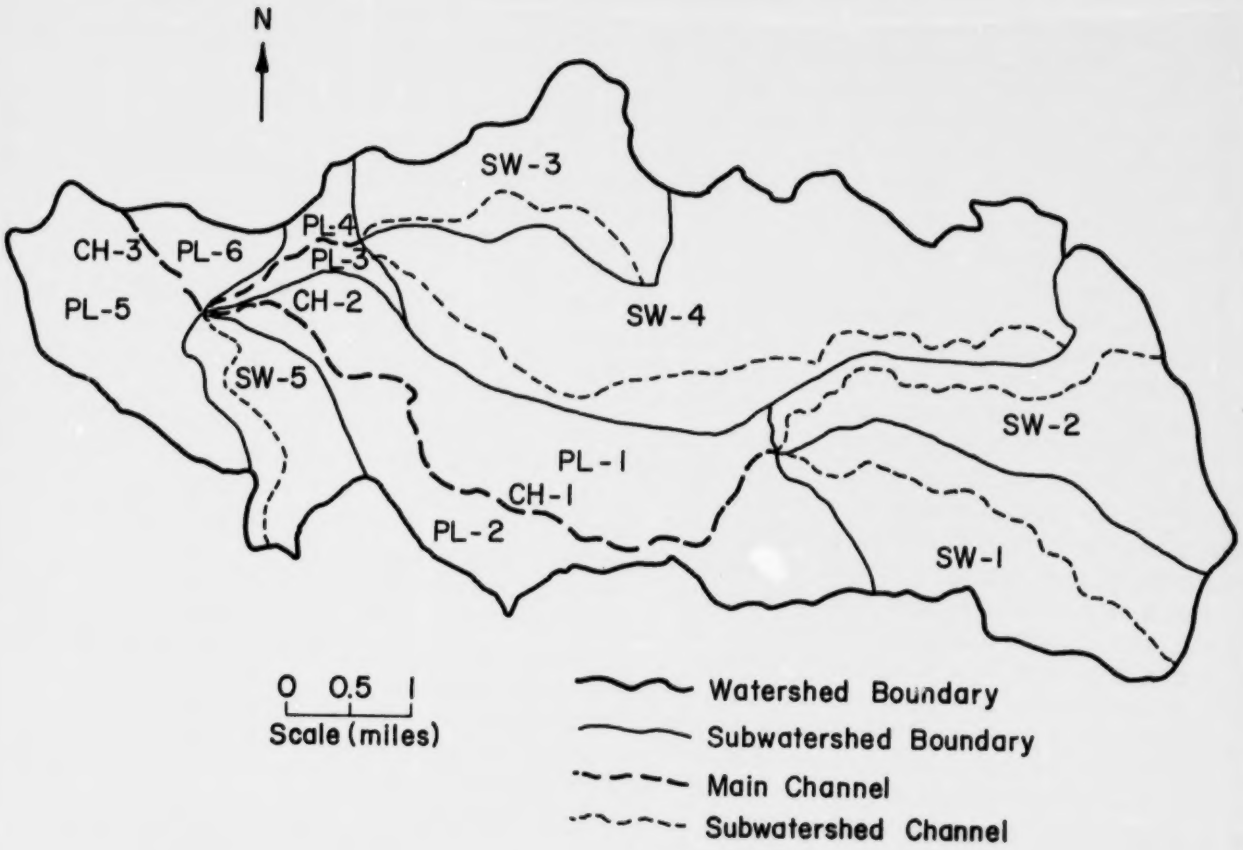


Figure 6. Subdivision of Complex Watershed (Woods Canyon, Arizona).

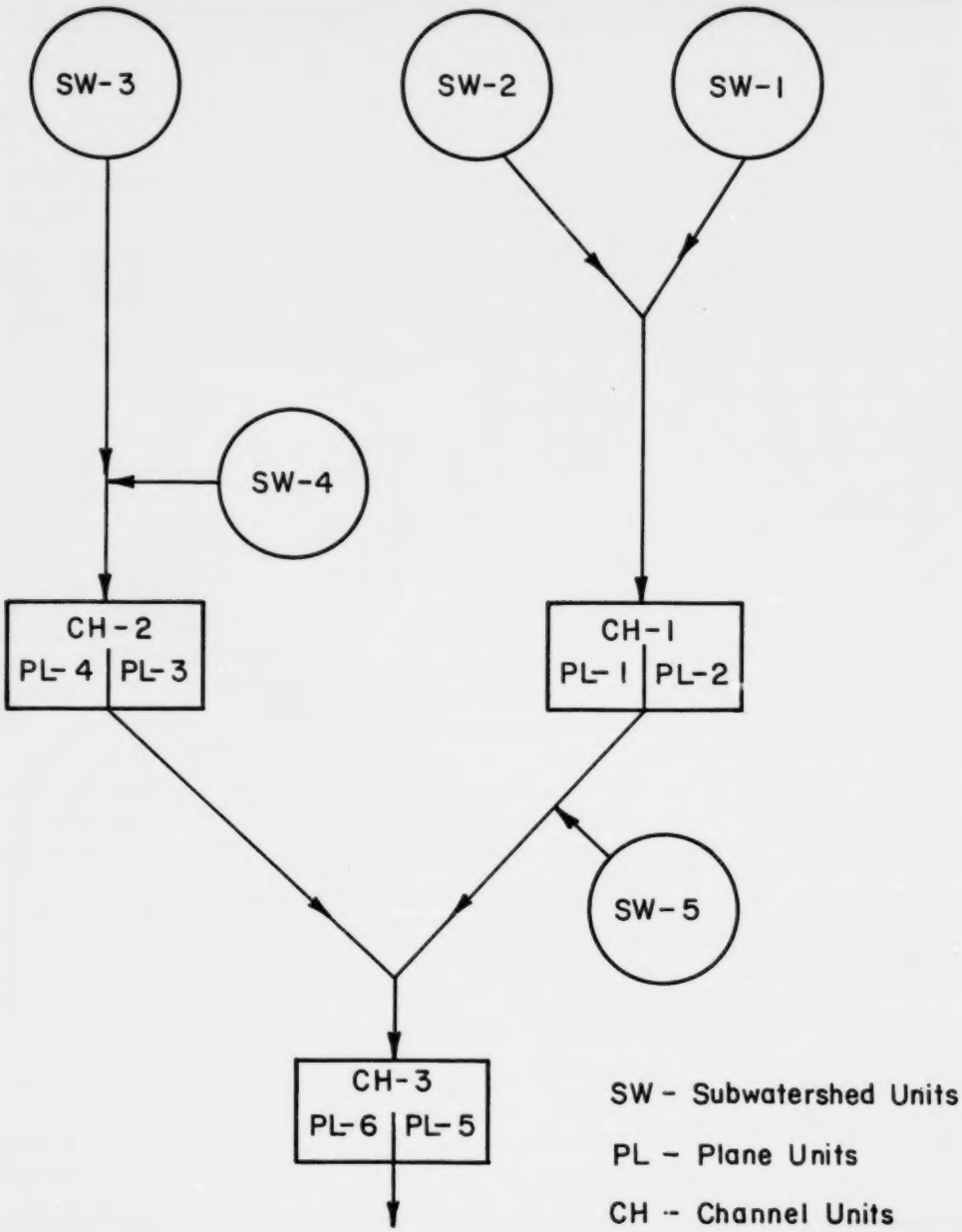


Figure 7. Schematic Representation of Watershed in Figure 6.

4. Do not calculate the response on any unit before all upstream units have been calculated.

5. Although there is no rule as to which branch needs to be calculated first when a confluence occurs, for the users own benefit a consistent convention should be used such as always calculating the left branch first. This will help eliminate confusion.

6. Because of model formulation, wherein the responses from plane units are written to one set of files and the responses from subwatershed units to another, rule 4 does not need to be strictly followed. As long as the relative sequence of flow between the plane units is maintained and similarly the relative sequence of flow between subwatershed units, the model will perform properly. It is recommended though that the planes and subwatershed units be distributed in their natural order to avoid confusion.

7. The data for all files, used in the program must be arranged consistent with the computation order.

The following paragraphs illustrate several possible sequences that could be used to model the watershed presented in Figures 6 and 7. An example of an improper sequencing is also provided. As stated earlier, there is no unique sequence. Referring to Figure 7, the responses for SW-1, SW-2, PL-1 and PL-2 must be calculated before the CH-1 response can be evaluated. Likewise, the SW-3, SW-4, PL-3 and PL-4 responses must be determined prior to calculation of the CH-2 response. After having calculated the CH-2 and CH-1 hydrographs, the hydrographs for SW-5, PL-5 and PL-6 must be evaluated before determining the final response for the watershed outlet, CH-3.

The files that contain data to be used in MULT must be arranged so that this order of calculation is maintained. A representation of a correctly

arranged data file for MULT is given in Figure 8a. Again, there is no unique sequence. For example, in Figure 8a the right branch of the above CH-1 was calculated before the left branch. However, the left branch could have been calculated first. The sequence would then be given by Figure 8b. Since all the responses from subwatershed units are written to a file different than those for the plane units, a sequence such as that in Figure 8c is also correct. The correct order of all plane units with respect to other plane units is maintained and similarly among the subwatershed units. It is however suggested that files such as the one illustrated in Figure 8c be avoided since they are not as straight forward, and do not present the natural sequence of flow as shown by those in Figures 8a and 8b. Figure 8d is an example of an incorrect file. Subwatershed unit 5 is out of place since it should appear before subwatersheds 3 and 4. It also should be repeated that once a branch is begun that the entire sequence of that branch is completed before shifting to another branch.

The user must note that even though there is no unique solution to the sequencing of the subwatershed and plane units, once a sequence is determined the same sequence must be followed in ordering all data input files to MULT. It is also suggested to alleviate the problem of deciding which branch above a confluence to calculate first, that a connection be adopted for setting up the governing sequence such as always calculating the left branch first.

The computational sequencing for the channel units must correspond to that of the plane and subwatershed units. For example the channel sequence for Figure 8a is:

CH-1
CH-2
CH-3

SW-1
SW-2
PL-1
PL-2
SW-3
SW-4
PL-3
PL-4
SW-5
PL-5
PL-6

a) Correct File with Right Branch Calculated First

SW-3
SW-4
PL-3
PL-4
SW-1
SW-2
PL-1
PL-2
SW-5
PL-5
PL-6

b) Correct File with Left Branch Calculated First

SW-1
SW-2
SW-3
SW-4
SW-5
PL-1
PL-2
PL-3
PL-4
PL-5
PL-6

c) Correct File with Right Branch Calculated First with Sub-watershed and Planes Separated

SW-1
SW-2
PL-1
PL-2
SW-5
SW-3
SW-4
PL-3
PL-4
PL-5
PL-6

d) Incorrect File, SW-5 should not be Calculated before SW-3 and SW-4

Figure 8. Sample Computational Sequences.

The proper channel sequence corresponding to Figure 8b is:

CH-2
CH-1
CH-3

The proper sequence corresponding to Figure 8c is:

CH-1
CH-2
CH-3

Since the sequence in Figure 8d is incorrect, no channel sequence can be written.

The sequence for the plane and subwatershed units is set up first in the file CONxxxx. The format of this file is given on the following page. For the first sequence in Figure 8a, CONxxxx would have the following form: The information contained within the parentheses does not actually appear on the file, but is used in this case to identify the different input variables. Note that the parameter ISEG is the number assigned to the unit in parentheses to the left, and that ISEG(I) = I.

TABLE 2. Sample Format For CONxxxx.

	6 (NPL)	5 (NWS)	
(SW-1)	1 (ISEG)	2 (ITYPE)	1 (IPRINT)
(SW-2)	2	2	1
(PL-1)	3	1	1
(PL-2)	4	1	1
(SW-3)	5	2	1
(SW-4)	6	2	1
(PL-3)	7	1	1
(PL-4)	8	1	1
(SW-5)	9	2	1
(PL-5)	10	1	1
(PL-6)	11	1	1

The file that controls the channel sequencing and also identifies units that serve as upstream or lateral inflows is FO9xxxx. Its appearance given in Table 3 for the case illustrated in Figure 8a.

TABLE 3. F09xxxx for Sequence Illustrated in Figure 8a.

Line	Column 1-10	Column 11-20	Column 21-30	Column 31-40	Column 41-50	Column 51-60	Column 61-70	Column 71-80	Column 81-90
1	6	5	3	10	20				
2	1	1	2		1	2			
3	2	3	4		3	4			
4	3	5			5	6	1	2	
5	.01								

Note in F09xxxx that the subwatershed and plane numbers are different from the ISEG values assigned in the permanent file CONxxxx. In F09xxxx the subwatersheds should be renumberd so that the first subwatershed unit appearing in CONxxxx is given the number 1, the second, 2 and so forth. The same is true for the planes with the first plane appearing in CONxxxx being numbered as 1 for F09xxxx, the second 2 and so forth. The channels are assigned the value ISEG(I) = I. When a channel unit is to be used as an upstream input to another channel, the value of ISEG corresponding to the upstream channel is used as the identification for the upstream channel.

NUTRINT

Nutrient output from watersheds depends primarily upon nutrient concentrations in the soil and corresponding water and sediment yields from the watersheds. The nutrient yield simulation model contained in this report may be used to continuously calculate nutrient concentrations in the soil and/or litter. The linked water and sediment simulation model provides necessary water and sediment yields for each simulation period. Based on the loading function concept adopted in this study, the enrichment factors involved also affect the amount of nutrient output from the watersheds.

Phosphorus

Sediment plays a more predominant role than water in transporting phosphorus from watersheds. Sediment yields due to management activities in the watershed may be recognized as an indicator for the loss of phosphorus from that watershed. The enrichment factors related to nutrient losses accompanying sediment loss, presented by Massey and Jackson (1952), are constant throughout the simulation.

Nitrogen

Sediment yields predominantly determine the phosphorus loss from watersheds. However, the most significant portion of nitrogen loss is determined by water. Studies by Moe et al. (1967), Linkens et al. (1970), Timmons et al. (1970), Kilmer et al. (1974), Klansner et al. (1974), Nicholls et al. (1974), Burwell et al. (1975), Kissel et al. (1976), and Hoyt et al. (1977) have demonstrated that water yields obviously affect the amount of nitrogen loss per unit area of watersheds or experimental plots. Their data have been analyzed in this study. The regression analysis of these data yields the following relationships for nitrogen enrichment factors.

$$R_{RNO} = 9.557 \times 10^{-3}\ Q^{(0.6195)} \tag{28}$$

$$R_{RNH} = 1.232 \times 10^{-4} + 5.11 \times 10^{-3}\ Q \tag{29}$$

$$R_{SNO} = 6.721 \times 10^{-4}\ Q^{(0.724)} \tag{30}$$

$$R_{SNH} = 8.661 \times 10^{-8}\ Q^{(0.982)} \tag{31}$$

where Q = water yield per unit area (m)

R_{RNO} = enrichment factor of nitrate in surface runoff (RLNO)

R_{SNO} = enrichment factor of nitrate in seepage (RLNL)

R_{RNH} = enrichment factor of ammonium in surface runoff (RLNH)

R_{SNH} = enrichment factor of ammonium in seepage (RLAL)

These relationships are used in Program NUTRINT and serve to reflect the effect of management activities on the nitrogen losses. The Fortran variable corresponding to the enrichment factor appears above in parentheses.

SECTION 3

FOREST MANAGEMENT EXAMPLES

INTRODUCTION

Due to the lack of data in forest areas, a hypothetical forest data set was constructed to demonstrate the model's capabilities and sensitivity to management activities. The hypothetical forest has an area of 123.6 ha (305.5 acres), is located at a latitude of 40°N and has a height of 1219.2 meters. A schematic map of the watershed is included in Figure 9. This map is assumed to have been derived from a topographic map in the manner described in Section 2. The undisturbed watershed is assumed to be 80% covered by a conifer canopy similar to Scots Pine. Input data characterizing the example will be discussed below, and data for the undisturbed response appear in examples of data file formats in Appendix A. Variations in inputs for the purpose of reflecting example timber harvest alternatives are also discussed.

PARAMETERS INSENSITIVE TO MANAGEMENT

Figure 9 shows that the watershed was subdivided into one two-plane unit, and two single-plane units surrounding a single main channel; no upstream connection unit was required. The sequence for the water and sediment routing is determined as in the earlier example and appears in Table 4 in the form of input file MLIxxxx. The order of the data inputs in files PARxxxx, EDAxxxx, SOIxxxx, MANxxxx, INIxxxx, INLxxxx, OXTxxxx, NUIxxxx, and VOIxxxx must be consistent with the order established in MLIxxxx. Input data therefore is expected in the previously mentioned files first for the two planes of the two plane-one channel watershed, then for each of the single planes bordering its main channel.

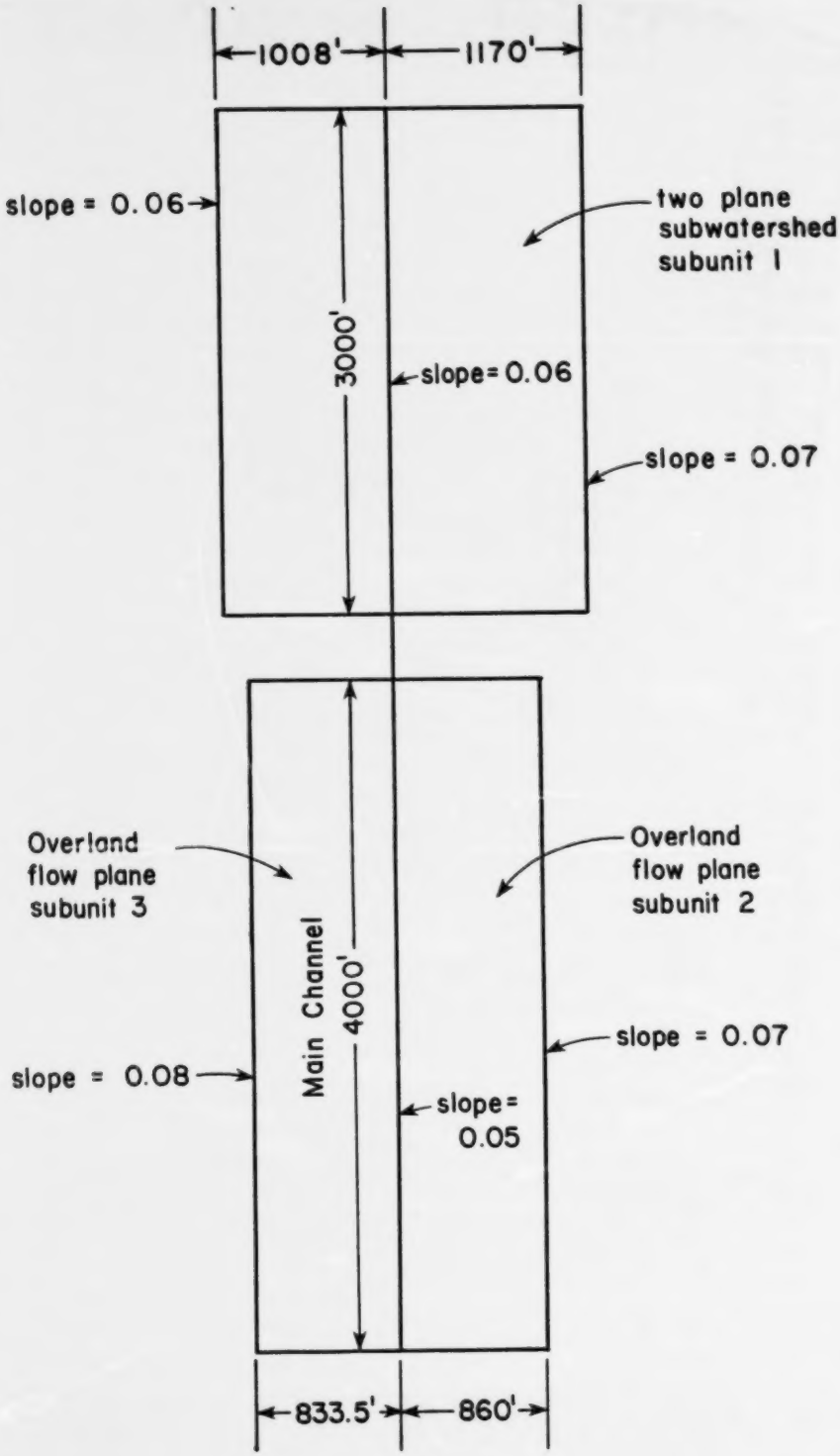


Figure 9. Schematic of Example Watershed.

TABLE 4. Sequencing for MULT and Form of Input File MLIxxxx.

1. NPL = 2

   NWS = 1

   NUMB = NPL + NWS = 3

2.

I	JSTAT (I)	JPLANE (I)
1	1	2
2	2	1
3	3	1

HYDROL accepts up to five soil layers and adjusts their moisture contents accordingly. The current formulation assumes the same properties for the lower four layers. The soil parameters are in Table 5. This data appears in PARxxxx, SOIxxxx, and BNKxxxx.

TABLE 5. Soil Data for Management Example.

Soil Layer	Layer Thickens (cm)	Field Capacity	Undisturbed Hydraulic Conductivity (cm/day)	Undisturbed Porosity	Final Degree of Saturation
1	50	.35	6.1	.50	1.0
2	60	.32	2.0	.45	1.0
3	103	.32	2.0	.45	1.0
4	103	.32	2.0	.45	1.0
5	103	.32	2.0	.45	1.0

The hydraulic properties of the soil are calculated in Subroutine SOIL of HYDROL from the following moisture tension data in Table 6.

TABLE 6. Soil Moisture Tension Data for Management Example.

	Moisture Content	Capillary Suction (cm)
Layer 1		
	.220	15000.
	.287	5000.
	.300	1000.
	.320	500.
	.325	300.
	.350	200.
	.400	100.
	.500	0.
Layer 2		
	.220	15000.
	.296	5000.
	.350	1000.
	.370	500.
	.380	300.
	.385	200.
	.425	100.
	.450	0.

These hydraulic properties are assumed to be laboratory data taken with no residual water, at a temperature of 15°C where the kinematic viscosity of water is 0.01138 cm^2/sec. Hypothetical soil grain sizes for the planes are given by data presented in Figure 10. The distribution is assumed to have a median diameter of 0.1 mm. The distribution is only given for the surface layer on each plane. The sediment distribution for the channel bed is given by Figure 11 for a median diameter of 5.0 mm.

It is important to note that the sediment distributions for the forest floor and the channel must be expressed in terms of the same set of grain size classes. In general, the channel distribution is coarser than the forest soil. Therefore, the percentages appearing in the coarser size class may be zero for forest soil and zero in the finer size classes for the channel bed.

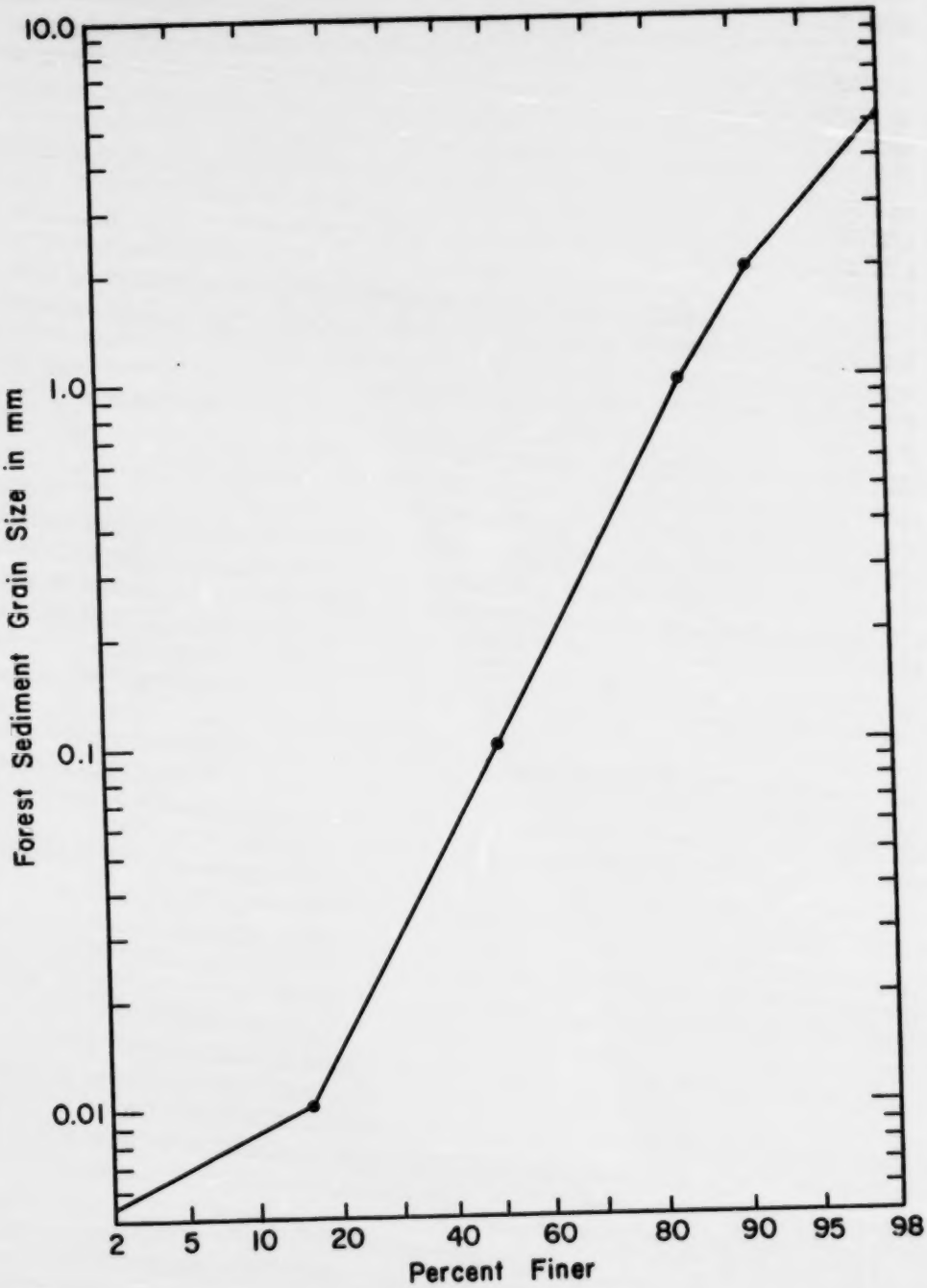


Figure 10. Grain Size Distribution for Forest Soil.

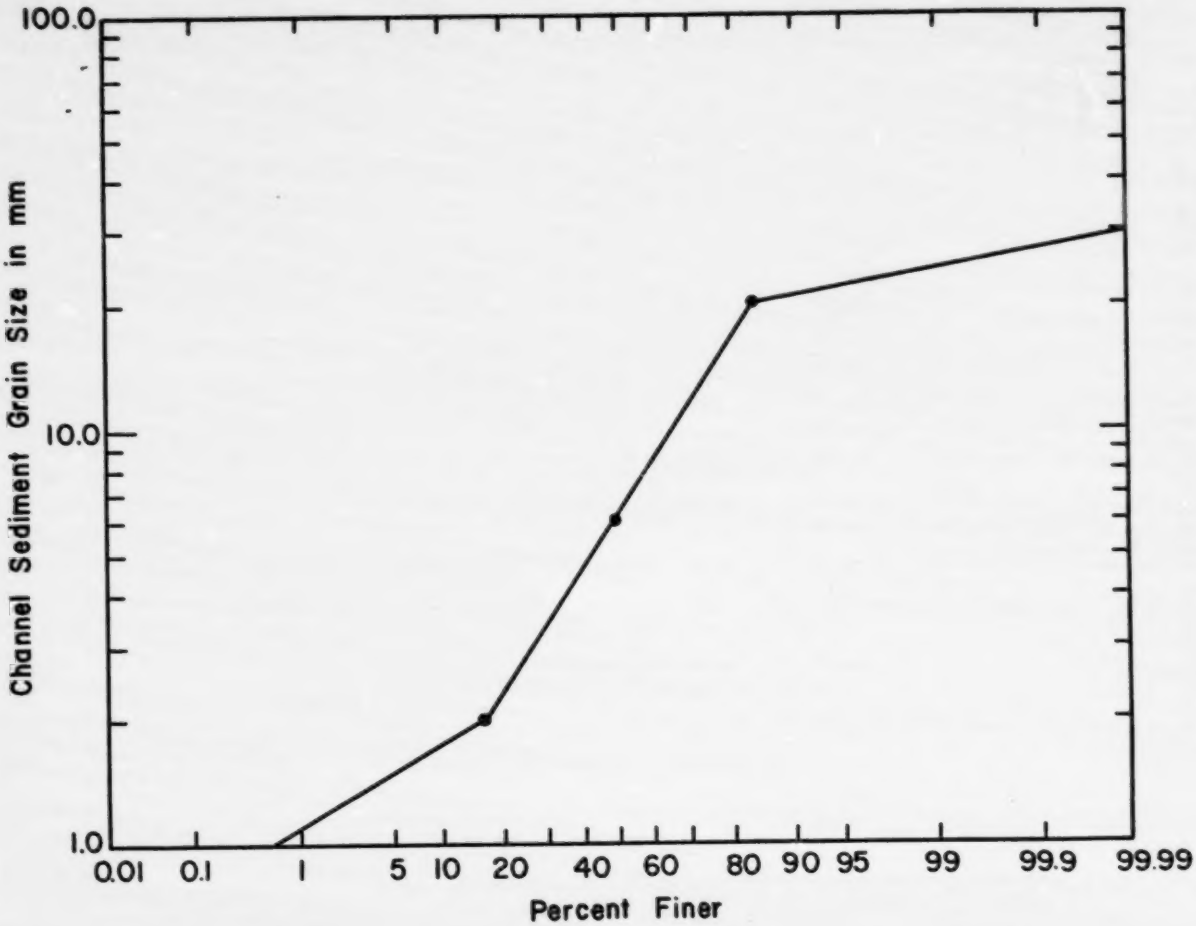


Figure 11. Grain Size Distribution for Channel Bed.

The percentages appearing in files PARxxxx and FIOxxxx in Appendix A serve as an example.

The vegetation covering the watershed is a species similar to Scots pine. The undisturbed canopy covers 80% of the watershed as was stated earlier. Further, it is assumed that the canopy dominates the evapotranspiration (ET) process. Therefore, the plant processes simulated in this model are those of the canopy. Values for the leaf area index growth curve appeared in Figure 1. The albedo of the canopy is 0.15.

Ground cover is assumed to contribute negligible water to the ET process, and in fact, it represents more than vegetation in this simulation. Ground cover is composed of material lying on the ground that serves to intercept rainfall, shield the soil surface from raindrop impact and contributes to the resistance to overland flow. In this example the ground cover is set at 80% for this undisturbed watershed.

Interception process subroutines require the maximum and minimum interception volumes for the canopy or dominant species. These volumes are expressed as volume of water held by the plants per unit area of ground completely covered by plants. The storage for the whole watershed is adjusted internally for variation in canopy cover and leaf area. These values may be a function of the plant species and they are found on the MANxxxx file as SIMAX and SIMIN respectively. The interception volume for ground cover is to be uneffected by management activity. The values for the undisturbed watershed are given in Table 7. These data are taken from Zinke, 1967. Finally, an

TABLE 7. Interception Volumes.

Minimum Canopy Interception Volume	0.03
Maximum Canopy Interception Volume	0.13
Ground Cover Interception Volume	0.03

average leaf length of 5.0 cm is assumed for the canopy. The resistance to overland flow is calculated as a function of the ground cover density and an upper value of the constant K in Eq. 32 below

$$f = \frac{K}{N_r} \tag{32}$$

where f is the Darcy-Weisbach friction factor and N_r is the flow Reynolds number. The upper bound on K in this example is 20,000.

The channel of the two plane-one channel watershed and the main channel are assumed to have a triangular cross section. The program MULT is designed to allow the cross sectional properties to be entered as power functions, however, in absence of this data, the triangular assumption allows all of these properties to be derived. If the channels are represented as shown in Figure 12, the following cross sectional relationship may be derived.

Area-wetted perimeter:

$$P = a_1 A^{b_1} \tag{33}$$

$$a_1 = \left[\frac{2}{\frac{1}{S_1} + \frac{1}{S_2}}\right]^{\frac{1}{2}} \left[\left(1 + \frac{1}{S_1^2}\right)^{\frac{1}{2}} + \left(1 + \frac{1}{S_2^2}\right)^{\frac{1}{2}}\right] \tag{34}$$

$$b_1 = 1/2$$

Depth-area:

$$y = a_2 A^{b_2} \tag{35}$$

$$a_2 = \left(\frac{2}{\frac{1}{S_1} + \frac{1}{S_2}}\right)1/2 \tag{36}$$

$$b_2 = 1/2$$

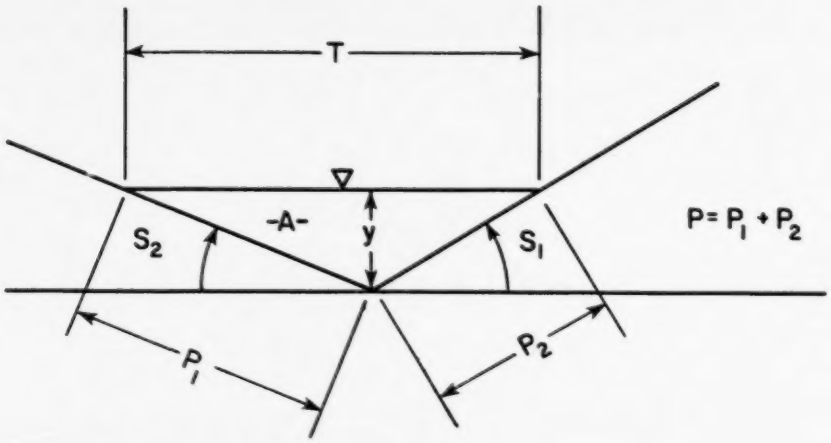


Figure 12. Definition Sketch for Triangular Channel.

Wetted perimeter-depth:

$$P = a_3 y^{b_3} \tag{37}$$

$$a_3 = \left(1 + \frac{1}{S_1^2}\right)^{\frac{1}{2}} + \left(1 + \frac{1}{S_2^2}\right)^{\frac{1}{2}} \tag{38}$$

$$b_3 = 1$$

Top width-area:

$$T = a_4 A^{b_4} \tag{39}$$

$$a_4 = \left[2\left(\frac{1}{S_1} + \frac{1}{S_2}\right)\right]^{\frac{1}{2}} \tag{40}$$

$$b_4 = 1/2$$

If Chezy's resistance law is used then discharge may be related to depth or cross sectional flow area as follows

$$Q = AC\sqrt{RS} \tag{41}$$

where

$$R = \frac{A}{P} \tag{42}$$

C is the Chezy resistance factor. It should be remembered that Chezy C has the units of $L^{\frac{1}{2}}/T$; therefore, the units of C must correspond to those being used. Since Darcy-Weisbach friction factor f is dimensionless, C may be easily calculated in any units from

$$C = \sqrt{\frac{8g}{f}} \tag{43}$$

by specifying the gravitational constant in appropriate units. A value of $f = 0.4$ was selected for the main channel segments of this watershed and $f = 38.82$ was selected for the channel of the upstream two plane-one channel

watershed. These values of f resulted in the Chezy C's of 25.38 and 100 in British units respectively that are used in this simulation. By using these values of C, the following flow-cross section property relationships for the main channel are derived

$$y = 0.2486Q^{0.4} \tag{44}$$

$$T = 6.659Q^{0.4} \tag{45}$$

where y is the depth of flow and T is the top width. As mentioned earlier, the cross sectional relationships are derived in this case for a triangular channel. If field data is available, these relationships may be obtained by regression and the resulting coefficients and exponents substituted for the derived area.

Values of the parameters a_i and b_i for this example are provided in Table 8.

TABLE 8. Channel Geometry Parameters.

i	a_i	b_i
	$S_1 = 0.07$	$S_2 = 0.06$
1	7.88	0.5
2	0.254	0.5
3	31.02	1
4	0.254	0.5
	$S_1 = 0.07$	$S_2 = 0.08$
1	7.34	0.5
2	0.106	0.5
3	26.86	1
4	0.106	0.5

Sediment routing in the watersheds balances sediment supply against transport capacity by size fraction. Sediment supply arises from detachment by raindrop impact or by the interaction of the flow and the land surface. The equations for the detachment process appear in Volume I as

$$Vr = a_5 i^{b_5} LW\ (1-\emptyset) \tag{46}$$

for raindrop detachment, where Vr is the volume of detachable sediment, a_5 is an empirically derived coefficient, i is the rainfall intensity, L and W are the length and width on the plane respectively, and $\emptyset$ is the soil porosity.

Coefficient a_5, and exponent b_5 are usually obtained by calibration. Values of $a_5 = 0.0014$ and $b_5 = 2.0$ are assumed in this example. For flow detachment,

$$V_p = D_f(V_t - V_r) \tag{47}$$

where V_f is the volume of sediment detached by flow, V_t is the total potential transport capacity and D_f is an empirical detachment coefficient. Eq. 47 is used both for overland flow and main channel flow. In this case a value of $D_f = 0.00001$ is used for overland flow, as detachment by raindrop impact usually dominates here; $D_f = 0.0001$ is used in the main channel.

Critical shear stress is used in the calculation of sediment transport capacity. The critical shear stress τ_i is calculated for each size fraction from Shields criterion of

$$\tau_i = \delta\gamma(S_s - 1)d_{s_i} \tag{48}$$

where δ is the value of Shields parameter, γ is the specific weight of water, S_s is the specific gravity of the sediment and d_{s_i} is the

representative grain size of the ith size fraction. For these examples the flow is assumed to have a grain size Reynolds number greater than 500, and δ is taken to be 0.05 as recommended by Gessler, 1971. The data discussed above reside on files PARxxxx, SOIxxxx, F10xxxx and BNXxxxx.

Meteorological data is input for the most part on files EDAxxxx and VOIxxxx. The contents on these files are measured data and are adequately described in Appendix A. However, an average barometric pressure of 1.0132 bars, and an average wind speed of 100 cm/sec appear on file PARxxxx. Initial value of soil moisture content appears on file INIxxxx.

The stream bank erosion model requires an equilibrium discharge and channel configuration representing the flow that last caused significant bank erosion. For this example the equilibrium discharge is assumed to be 28.32 m^2/sec (1000 cfs). Using the channel relationships described above, the equilibrium depth is 0.9464 m; equilibrium width is 25.36 m. The remaining data inputs were described above or are described in Appendix A; these data are on file BNKxxxx.

Forest litter data is required by both NUTRINT and the litter loading model RILL. Litter serves as a source of nitrogen; therefore, the annual forest litter production rate and the initial depth of chemically active litter are inputs to NUTRINT. The loading model requires the same data in different units. The initial depth of litter averaged over the watershed is estimated at 3.0 cm. For the nutrient model, only half of this depth (1.5 cm) is assumed to be active. Assuming a litter bulk density of 0.7 g/cm^3 and and a canopy cover of 0.8, the average quantity of active litter is 84,000 $\frac{kg}{ha}$. The total initial quantity of litter per square meter used in RILL is therefore 16.8 $\frac{kg}{m^2}$. These data are found on file INIxxxx.

The litter production rate is assumed to be 1 $\frac{cm}{yr}$, that is 56,000 $\frac{kg}{ha\text{-}yr}$ or 5.6 $\frac{kg}{m^2 yr}$.

INITIAL CONDITIONS

Three of the subprograms, HYDROL, NUTRINT and RILL require initial conditions. These values reside on file INIxxxx. A description of INIxxxx appears in Appendix A along with a list of the file used in these examples. All values are assumed.

TIMBER HARVEST EXAMPLE

There are several methods for harvesting timber from forest lands. Four such methods of clear-cutting will be examined in this example. These techniques include harvest by tractor, high lead, skyline and balloon. Impacts on the forest vary considerably between methods as do the costs. In addition, the choice of method is often constrained by the physical attributes of the watershed. Selection of the appropriate method is therefore a compromise between harvests costs, severity of impact and applicability of the method. This simulation allows comparison of harvest techniques with respect to non-point source pollution impacts.

Estimates of model parameters are based on descriptions of the above alternatives found in silviculture literature. The following table appears in "Process, Procedures, and Methods to Control Pollution Resulting from Silviculture Activities" (USEPA, 1973). The same source indicates the bulk

TABLE 9. Effects of Log Transport System on Forest Soils.

Log Transport System	Percentage of Logged Watershed with Bare Soil	Percentage of Logged Watershed with Compacted Soil
Balloon	6.0	1.7
High lead	14.8	9.1
Tractor	35.1	26.4

density of the soil in the compacted area is increased in varying degree by the alternative methods. For this example the following increases in bulk density are assumed for the alternatives.

TABLE 10. Increases in Bulk Density.

Log Transport Method	Percentage of Logged Watershed with Compacted Soil	Percent Change in Bulk Density	Changed Watershed Porosity
Balloon	1.7	25.0	0.43
High lead	9.1	33.7	0.41
Tractor	26.4	48.2	0.37

(This change for balloon transport is assumed)

The values for disturbed porosity are obtained by relating Bulk Density, ρ_B, to porosity by the expression

$$\rho_B = \frac{(1-\phi)V_T\rho_s}{V_T} \tag{49}$$

where ρ_B is the density of soil, V_T is the total soil volume and ϕ is the porosity. Therefore

$$\frac{\Delta\rho_B}{\rho_s} = -\Delta\phi \tag{50}$$

or

$$\frac{\Delta\rho_B/\rho_{B_o}}{\rho_s/\rho_{B_o}} = -\Delta\phi$$

where ρ_{B_o} is the undisturbed value of bulk density. Assuming a specific gravity of 2.65 for the soil grams an undisturbed bulk density of 0.7 g/cm^3 and initial porosity of 0.5 provides the values for compacted porosity found in Table 10.

As indicated in Table 9 the ground disturbance only occurs on a portion of the watershed. Since the values of soil parameters used by the model are averaged over each plane, a mean value of the parameters is obtained using the percents of disturbed-undisturbed areas as a weighting function. For example, the average hydraulic conductivity K_{s_d} of the disturbed plane is calculated by the following expression:

$$K_{s_d} = \frac{(1-A_c)}{A_T} K_{s_o} + \frac{A_c}{A_T} K_{s_c} \tag{51}$$

where A_c is the area of the compacted portion of the plane, A_T is total area of the plane, K_{s_o} is the undisturbed hydraulic conductivity and K_{s_c} is the hydraulic conductivity of the compacted region. Porosity and ground cover are adjusted in similar fashion.

The changes in sensitive parameters to simulate the timber harvest schemes are summarized in Table 11.

TABLE 11. Parameter Changes Reflecting Timber Harvest.

Parameter	Baseline	Balloon	High Lead	Tractor
Porosity	0.5	0.43	0.41	0.37
Saturated Hydraulic Conductivity (cm/day)	6.10	6.01	5.60	4.65
Ground Cover Density	0.8	0.76	0.70	0.55
Canopy Cover Density	0.8	0.	0.	0.
Forest Litter Production Rate (kg/m^2-yr)	5.6	0.	0.	0.
NALT1	1	2	3	4

As mentioned earlier, the value of conductivity is area weighted based on compacted and uncompacted areas. The value of saturated hydraulic conductivity in the compacted zone is assumed to be 0.61 cm/day. Similarly the ground cover density in the base soil zone is assumed to be reduced to 0.10. NALT1 is the index in file SOIxxxx representing the alternative number.

The results of simulated timber harvest techniques are summarized in Table 12. The values presented are simulation period total yields compiled by subprogram GOALSUM. Two storm hydrographs are provided in Figures 13 and 14. During the five month simulation period there are 11 storms producing runoff. Depending on the alternative, three or four storms are of sufficient size (total volume > 0.13 cm) to produce significant sediment. The storms of May 28, 1972 and June 5, 1972 are plotted as examples. Differences in peak discharge are evident in these plots. The balloon transport method produced very little impact in the example and was omitted from the plots for clarity.

The results of the timber harvest example are consistent with measurements reported in EPA 1973. In monitoring sediment losses after timber harvest in Oregon, an increase in sediment yield of 329% over the undisturbed watershed was noted after clear-cutting by skyline with no roads. This result is higher than the result simulated for High Lead; however, the Oregon soil was also considered very unstable and on steeper slopes.

GRAZING ACTIVITY EXAMPLE

Overgrazing of watersheds can lead to lead sediment losses as a result of trampling and ground cover removal. This example is based on a study by McGuity, Simons and Merrill (1970) that compared the influences of heavy grazing and pasture rotation with an undisturbed site. These authors noted that final infiltration rates may be halved by heavy grazing but may be only slightly lowered by pasture rotation. Ground cover densities after rotation grazing may actually increase while a removal of one third of the standing

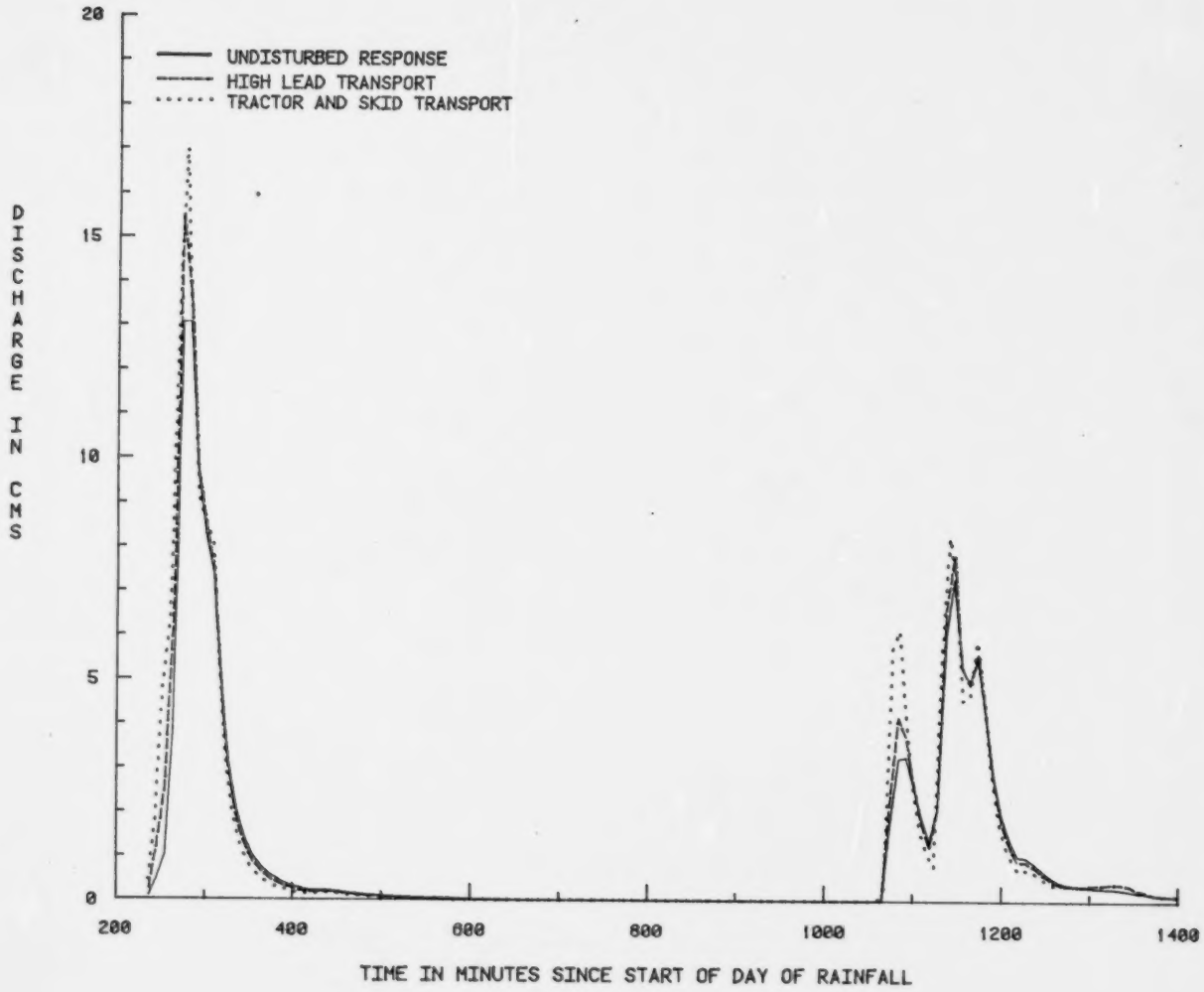


Figure 13. Timber Harvest Alternatives: Storm of May 28, 1972.

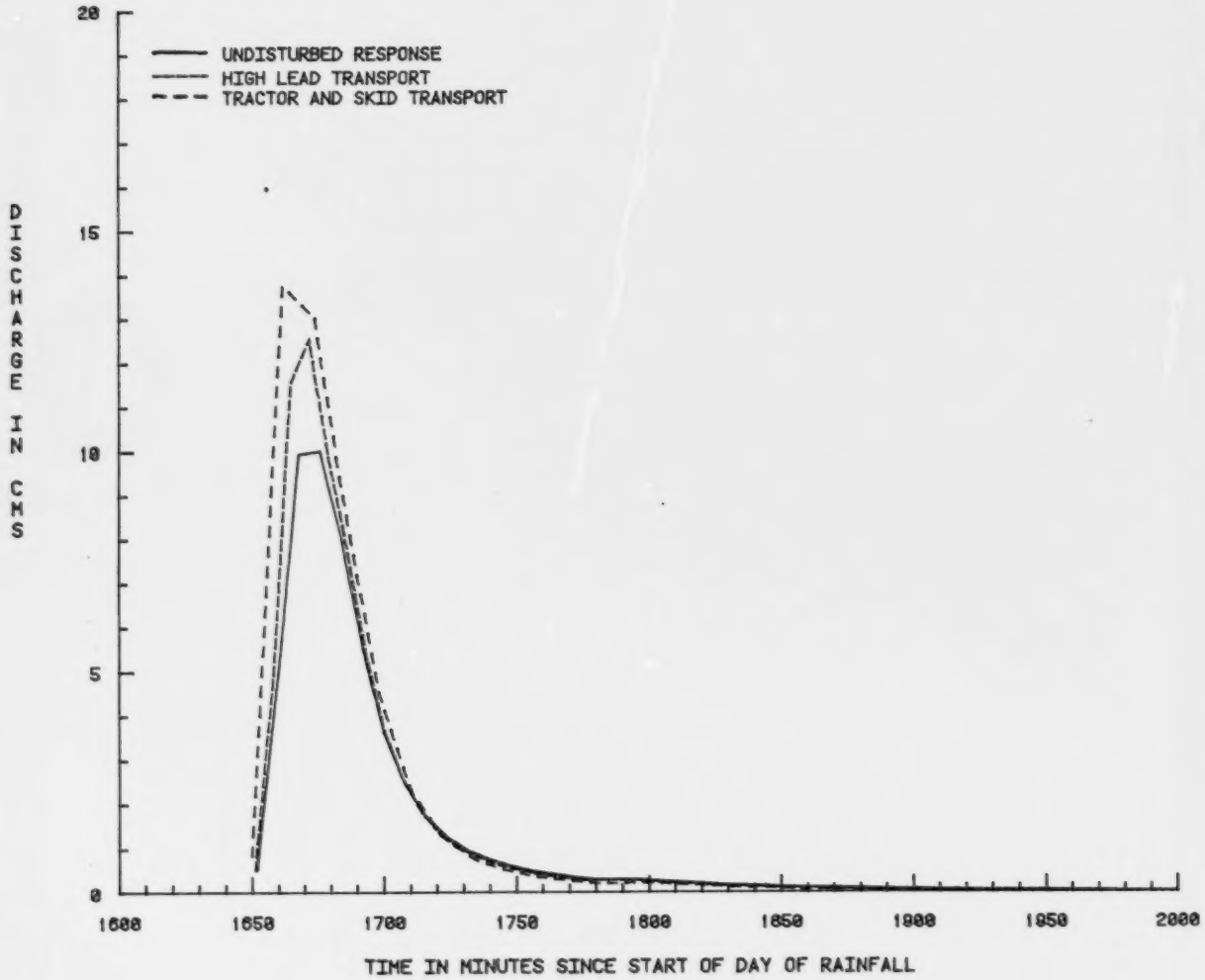


Figure 14. Timber Harvest Alternatives: Storm of June 5, 1972.

TABLE 12. Summary of Yields for Timber Harvest Alternatives.

Yield	Undisturbed	Balloon	High Lead	Tractor
Water Yield (cm)	18.51	19.39	20.36	22.75
Sediment Yield (kg)	3.307×10^4	5.438×10^4	7.798×10^4	1.999×10^5
Dissolved Oxygen (kg)	1173	1199	1260	1441
Thermal Loading (kJ)	2.889×10^9	3.054×10^9	3.152×10^9	4.311×10^9
Nitrogen (kg)	40.44	56.43	79.38	184.2
Phosphorus (kg)	24.46	37.61	55.71	138.6
Litter (kg)	4.609×10^6	4.050×10^6	4.055×10^6	4.065×10^6

phytomass was noted under heavy grazing pressure. Compactioning of soils was also manifested in a decrease in pore space in both alternatives. The sensitive parameter inputs for the grazing examples are summarized in Table 13.

TABLE 13. Parameter Changes Reflecting Grazing Activity.

Parameter	Baseline	Rotation	Heavy Continuous
Porosity	0.5	0.90	0.37
Saturated Hydraulic Conductivity	6.10	5.00	3.0
Ground Cover	0.8	0.9	0.53
NALT1	1	2	3

The results of the simulation of grazing alternatives is summarized in the same manner as timber cutting example. The comparison of simulation period (5 months) yields appear in Table 14. Comparison of runoff hydrographs occurring on May 28, 1972 and June 5, 1972 appear in Figures 15 and 16.

TABLE 14. Summary of Yields for Grazing Activity Alternatives.

Yield	Undisturbed	Rotation	Heavy Continuous
Water Yield (cm)	18.51	21.57	25.52
Sediment Yield (kg)	3.307×10^4	1.969×10^4	2.280×10^5
Dissolved Oxygen (kg)	1173	1264	1589
Thermal Loading (kJ)	2.889×10^4	3.079×10^9	4.447×10^9
Nitrogen (kg)	40.44	28.96	210.5
Phosphorus (kg)	24.46	13.31	154.1
Litter (kg)	4.609×10^6	4.627×10^6	4.644×10^6

INTERFACE WITH GOAL PROGRAMMING

Tables 12 and 14 illustrate a management response matrix for nonpoint source pollution yields from the example watershed. Various alternatives have been simulated and the change in response allows a representation of the impact of timber harvest over a range of alternatives. The GOAL program attempts to select the best management practice by minimizing penalties due to pollution while maximizing benefits derived. The cost of individual management alternatives is also considered. Performing such optimization would require enormous computation time if the hydrologic model were directly

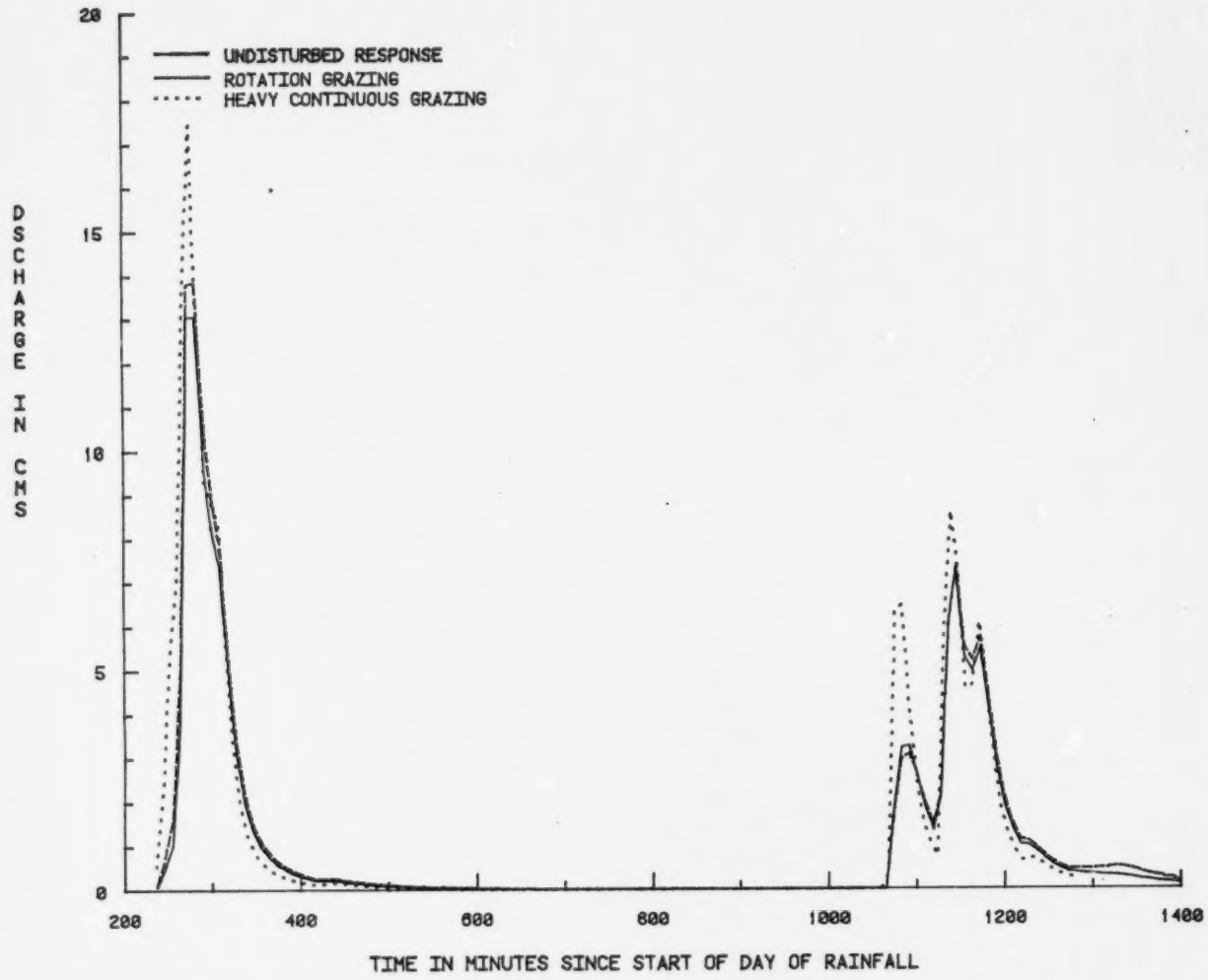


Figure 15. Grazing Activity Alternatives: Storm of May 28, 1972.

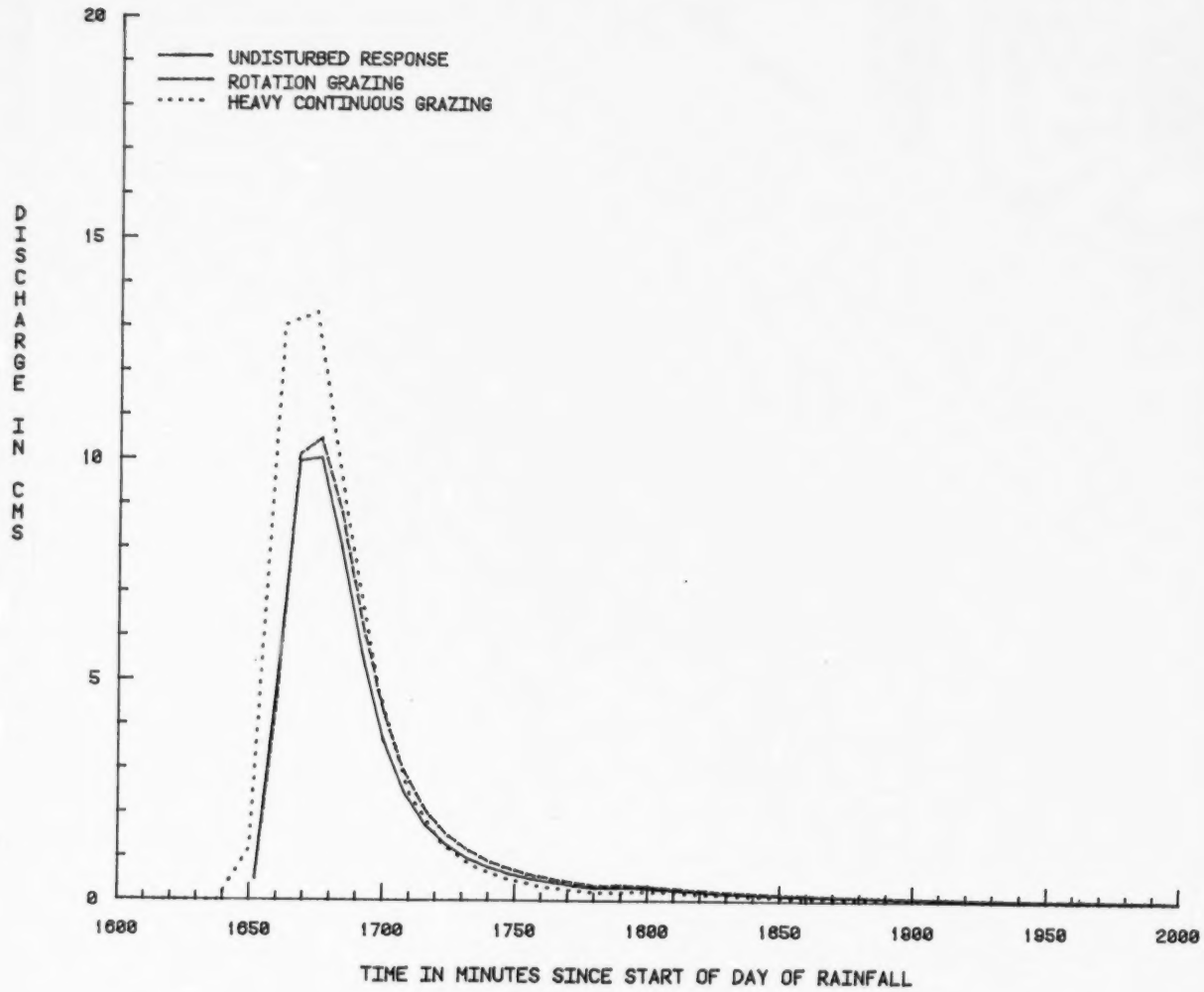


Figure 16. Grazing Activity Alternatives: Storm of June 5, 1972.

iterated to predict impacts. By establishing a response matrix, approximations to the simulation may be obtained by interpolation between the simulated alternatives or degree of alternatives application. Therefore, matrices such as illustrated by Tables 12 and 14 serve as the direct link with the GOAL planning model.

REFERENCES

Burwell, R. E., D. R. Timmons, and R. F. Holt. 1975. Nutrient Transport in Surface Runoff as Influenced by Soil Cover and Seasonal Periods. Soil Sci. Soc. Amer. Proc., Vol. 39. pp. 523-528.

Cowan, I. R., and F. L. Milthorpe. 1968. Plant Factors Influencing the Water Status of Plant Tissues. In: Water Deficits and Plant Growth, Vol. 1. T. T. Kozlowski (Ed.). Academic Press, New York. pp. 137-193.

Goldstein, R. A., J. B. Mankin, and R. J. Luxmoore. 1974. Documentation of PROSPER, A Model of Atmosphere-Soil-Plant Water Flow. Oak Ridge National Laboratory, EDFB-IBP-73-9, Oak Ridge, Tennessee.

Hoyt, G. D., E. O. McLean, G. Y. Reddy, and T. J. Logan. 1977. Effects of Soil, Cover Crop, and Nutrient Source on Movement of Soil, Water, and Nitrogen under Simulated Rain-Slope Conditions. J. Environ. Quality, Vol. 6, No. 3. pp. 285-290.

Kilmer, V. J., J. W. Gilliam, J. F. Lutz, R. T. Joyce, and C. D. Eklund. 1974. Nutrient Losses from Fertilized Grassed Watersheds in Western North Carolina. J. Environ. Quality, Vol. 3, No. 3. pp. 214-219.

Kissel, D. E., C. W. Richardson, and E. Burnett. 1976. Losses of Nitrogen in Surface Runoff in the Blackland Prairie of Texas. J. Environ. Quality, Vol. 5, No. 3. pp. 288-292.

Klausner, S. D., P. J. Zwerman, and D. F. Ellis. 1974. Surface Runoff Losses of Soluble Nitrogen and Phosphorus under Two Systems of Soil Management. J. Environ. Quality, Vol. 3, No. 1. pp. 42-46.

Likens, G. E., F. H. Bormann, N. M. Johnson, D. W. Fisher, and R. S. Pierce. 1970. Effects of Forest Cuttings and Herbicide Treatment on Nutrient Budgets in the Hubbard Brook Watershed-Ecosystem. Ecological Monographs, Vol. 40, No. 1. pp. 23-47.

McGinty, W. A., F. E. Smeins, and L. B. Merrill. 1979. Influence of Soil, Vegetation, and Grazing Management on Infiltration Rate and Sediment Production of Edwards Plateau Rangeland. J. of Range Management, Vol. 32, No. 1, pp. 33-37.

Moe, P. G., J. V. Mannering, and C. B. Johnson. 1967. Loss of Fertilizer Nitrogen in Surface Runoff Water. Soil Sci., Vol. 104, No. 6. pp. 389-394.

Nicholls, K. H., and H. R. MacCrimmon. 1974. Nutrients in Subsurface and Runoff Waters of Holland Marsh, Ontario. J. Environ. Quality, Vol. 3, No. 1. pp. 31-35.

Rutter, A. J. 1967. An Analysis of Evaporation from a Stand of Scots Pine. From Forest Hydrology, W. E. Sopper and H. W. Lull (Eds.), Pergamon Press, New York.

Simons, D. B., R. M. Li, K. G. Eggert, J. N. Ho, W. T. Fullerton, V. M. Ponce, and N. Duong. 1984. Simulation Model for Watershed Management Planning. Volume I: Model Theory and Formulation. Prepared for U.S. Environmental Protection Agency, Athens, Georgia.

Swift, L. W., W. T. Swank, J. B. Mankin, R. J. Luxmoore, and R. A. Goldstein. 1975. Simulation of Evapotranspiration and Drainage from Mature and Clear-Cut Deciduous Forests and Young Pine Plantations. Water Resources Research 11(5):667.

Tennessee Valley Authority, Division of Water Control Planning, Engineering Laboratory. 1972. Heat and Mass Transfer between a Water Surface and the Atmosphere. Water Resources Research, Laboratory Report No. 14, Norris, Tennessee.

Timmons, D. R., and R. F. Holt. 1970. Leaching of Crop Residues as a Source of Nutrients in Surface Runoff Water. Water Resource Research, Vol. 6, No. 5. pp. 1367-1375.

U.S. Environmental Protection Agency. 1973. Processes, Procedures, and Methods to Control Pollution Resulting from Silvicultural Activities. EPA Report 430/9-73-010.

Zinke, P. J. 1967. Forest Interception Studies in the United States. From Forest Hydrology, W. E. Sopper and H. W. Lull (Eds.), Pergamon Press, New York.

APPENDIX A

INPUT DESCRIPTION

INPUT FILES

This section contains a description of the input files which are needed in order to execute the model simulation. These input files contain the numerical data and decision parameters needed by the FORTRAN programs. Each input file is used by at least one of thirteen FORTRAN programs. These FORTRAN programs, along with the system commands, constitute the model simulation. First, the input files, which the user must create in order to use the model, are described. Then, the input files which are program created are described. Finally, the input files which are associated with each FORTRAN program are listed.

USER CREATED FILES

There are sixteen input files which the user needs to create. They are, in order of their description: MLIxxxx, INIxxxx, PARxxxx, SOIxxxx, EDAxxxx, VOIxxxx, F09xxxx, F10xxxx, QUPxxxx, OYTxxxx, NUIxxxx, BNKxxxx, INLxxxx, GOAxxxx, MANxxxx, and SNOxxxx.

File: MLIxxxx is a permanent file, which is used as TAPE4 by the FORTRAN program HYDROL and as TAPE9 by the FORTRAN program EXMIN.

The inputs on the file MLIxxxx are:

1. NPL, NWS

   FORMAT: 2I10

   NPL is the number of single planes in the simulation.

   NWS is the number of watersheds (2 planes and 1 channel) in the simulation.

From these two variables, the number of simulated units (NUMB) is calculated by the formula:

NUMB = NWS + NPL

And the number of planar units (NOPL) is calculated by the formula:

NOPL = NWS*2 + NPL

2. NUMB + 1. JSTAT, JPLAN

FORMAT: 2I10

JSTAT is the unit number which is to be simulated.

JPLAN is the number of planes in the corresponding unit; the permissible values are 1 or 2.

File: INIxxxx is a permanent file, which is used as TAPE52 by the FORTRAN programs HYDROL, NUTRINT, SBEROS, AND RILL. The initial values of the variables in this file must be defined by the user. The FORTRAN programs HYDROL, NUTRINT, SBEROS, and RILL write to TAPE53 the values of the variables in this file for the next simulation year. After the end of the present simulation year, the system copies TAPE53 to TAPE52. Then, this process is repeated until the end of the simulation. Note that HYDROL writes on TAPE53 those values which it will use as inputs. Similarly, NUTRINT writes its inputs, SBEROS its inputs, and RILL its inputs.

The inputs on the file INIxxxx, which are read by the program HYDROL, are:

1. This portion of the file is grouped into NOPL sets (see description of file MLIxxxx), one set for each plane.

(THETA(I), I = 1,5)

FORMAT: 5G10.3

THETA contains the initial moisture contents in centimeters for the five soil layers.

The inputs which are read by the program NUTRINT are:

2. IDUM

   FORMAT: A2

   IDUM is an end-of-file mark (EOF).

3. This portion of the file is grouped into NOPL sets (see description of file MLIxxxx), one set for each plane.

   A. (XS(J), J = 1,14)

      FORMAT: 8F10.5

      XS(1) is the concentration of organic nitrogen in the upper litter or soil zone in the watershed in kilograms per cubic meter.

      XS(2) is the concentration of ammonium in the upper litter or soil zone in the watershed in kilograms per cubic meter.

      XS(3) is the concentration of nitrate in the upper litter or soil zone in the watershed in kilograms per cubic meter.

      XS(4) is the concentration of organic nitrogen in the lower litter or soil zone in the watershed in kilograms per cubic meter.

      XS(5) is the concentration of ammonium in the lower litter or soil zone in the watershed in kilograms per cubic meter.

      XS(6) is the concentration of nitrate in the lower litter or soil zone in the watershed in kilograms per cubic meter.

      XS(7) is the concentration of nitrogen in plants of the watershed in kilograms per square meter.

      XS(8) is the concentration of soluble ammonium in soil of the watershed in kilograms per cubic meter.

      XS(9) is the concentration of nitrate in the soil in kilograms per cubic meter.

      XS(10) is the concentration of adsorbed ammonium in soil in kilograms per cubic meter.

      XS(11) is the total nitrogen loading through runoff and subsurface flow in kilograms.

XS(12) is the nitrate loading through runoff water in kilograms.

XS(13) is the ammonium loading through runoff water in kilograms.

XS(14) is the inorganic nitrogen loading to groundwater in kilograms.

(XS(I), I = 11,14) must be initialized equal to 0.0.

B. (XT(J), J = 1,11)

FORMAT: 8F10.5

XT(1) is the concentration of organic phosphorus in the upper litter or soil zone in kilograms per cubic meter.

XT(2) is the concentration of inorganic phosphorus in the upper litter or soil zone in kilograms per cubic meter.

XT(3) is the concentration of organic phosphorus in the lower litter or soil zone in kilograms per cubic meter.

XT(4) is the concentration of inorganic phosphorus in the lower litter or soil zone in kilograms per cubic meter.

XT(5) is the concentration of phosphorus contained in plants of the watershed in kilograms per square meter.

XT(6) is the concentration of inorganic phosphorus dissolved in soil water in kilograms per cubic meter.

XT(7) is the concentration of inorganic phosphorus adsorbed to soil particles in kilograms per cubic meter.

XT(8) is the total phosphorus loading through runoff and subsurface flow in kilograms.

XT(9) is the phosphorus loading through sediment in kilograms.

XT(10) is the ortho-phosphate loading through runoff water in kilograms.

XT(11) is the ortho-phosphate loading to groundwater in kilograms.

(XT(I), I = 8,11) must be initialized equal to 0.0.

C. DO

FORMAT: F10.5

DO is the initial active nutrient mass of litter in kilograms per hectare.

The inputs which are read by the program SBEROS are:

4. IDUM

FORMAT: A2

IDUM is an end-of-file mark (EOF).

5. This portion of the file is grouped into NDX (set internally to five in MCHNL) sets:

QEQU, DEQU, WEQU

FORMAT: 3F15.5

QEQU is the equilibrium water discharge in cubic meters per second.

DEQU is the equilibrium flow depth in meters.

WEQU is the equilibrium channel width of the section in meters.

The inputs which are read by the program RILL are:

6. IDUM

FORMAT: A2

IDUM is an end-of-file mark (EOF).

7. This portion of the file is grouped into NPL sets (see description of file INLxxxx), one set for each plane, (note that NPL = NOPL).

FLIT

FORMAT: F10.0

FLIT is the initial amount of forest litter production in kilograms per square meter.

File: PARxxxx is a permanent file, which is used as TAPE2 by the FORTRAN program HYDROL.

The inputs on the file PARxxxx are:

1. CASEI

   FORMAT: 20A4

   CASEI identifies the simulation problem and is the title used to describe the environmental data.

2. LLDAY, ALSR, ALSS

   FORMAT: I2, 2F10.4

   LLDAY is used to indicate whether daily values of certain variables (infiltration, interception, evapotranspiration, etc.) should be printed. A value of 0 indicates that daily values will not be printed, otherwise, they will be.

   ALSR is the solar altitude at sunrise in degrees, $0 \leq ALSR \leq 90.0$.

   ALSS is the solar altitude at sunset in degrees, $0 \leq ALSS \leq 90.0$.

3. (DL(I), I = 1,5)

   FORMAT: 5G10.3

   DL is an array containing the thickness in centimeters of the top five soil layers. The top layer corresponds to the index I = 1.

4. (FC(I), I = 1,5)

   FORMAT: 5G10.3

   FC contains the field capacities of the five soil layers in the fraction of total volume of each layer.

5. PAIR, CPO, XL, V

   FORMAT: 4G10.3

   PAIR is the air pressure in bars.

   CPO is the specific heat of air at constant pressure in calories per gram-degrees Kelvin.

   XL is the average length of a leaf in centimeters.

   V is wind velocity in centimeters per second.

6. AT(1), AT(2), ARAT(1), ARAT(2), GM, GV

FORMAT: 6G10.3

AT contains the root cross-sectional area per unit area of soil for the two soil layers containing roots.

ARAT is the fraction of roots in each of the two soil layers containing roots.

GM is the mean energy flow from the ground to the surface in langleys per day.

GV is the mean peak variation in energy flow from the ground to the surface in langeleys per day.

7. (SW(I), I = 1,5)

FORMAT: 5F10.5

SW is the degree of saturation in the wetted zone, for the five soil layers.

8. ALBGR, TRCAN, SIGRN

FORMAT: 3F10.5

ALBGR is the albedo of the ground.

TRCAN is the transmissivity of canopy.

SIGRN is the interception volume of the ground cover in centimeters.

9. SLLGT(1), SLOPE(1), ASPP

FORMAT: 2F10.5

SLLGT(1) is the length of the plane in meters.

SLOPE(1) is the slope of the plane.

ASPP is the aspect of the slope in degrees from north, $0 \leq ASPP \leq 360.0$.

10. SLLGT(3), SLOPE(3)

FORMAT: 2F10.5

SLLGT(3) is the width of the plane in meters.

SLOPE(3) is the slope of the channel.

11. C1, XN, A1, B1, RESIS

FORMAT: 5F10.5

C1 is Chezy's C.

XN is Manning's N, and either XN or C must be zero.

A1 is the coefficient in and area-perimeter relationship (P =

A1 * A ** B1). Set it equal to zero for a triangular relationship.

B1 is the exponent in the area-perimeter relationship (P = A1 * A ** B1).

RESIS is the upper limit on the coefficient in the Darcy-Weisbach friction factor equaton for overland flow.

12. RDETC, EXPON, FDETC, FDETO, SHIEL

FORMAT: 5F10.5

RDETC is the detachment coefficient in the equation for sediment detachment due to rainfall energy.

EXPON is the detachment exponent in the equation for sediment detachment due to rainfall energy.

FDETC is the detachment coefficient in the equation for sediment detachment due to the channel.

FDETO is the detachment coefficient in the equation for sediment detachment due to overland flow.

SHIEL is the parameter in Shield's diagram governing the incipient motion of sediment grains.

13. CDMAX, CVDEN, THSHD, CALDF, ENGBL, FREWT, ONTRS

FORMAT: 7F10.5

CDMAX is the maximum cover density.

CVDEN is the fraction of the ground or snow surface shaded from direct sunlight or radiation.

THSHD is the threshold temperature in degrees Fahrenheit for determining when to reinitialize the reflectivity function.

CALDF is the number of calories needed to bring the snowpack temperature to zero degrees centigrade.

ENGBL is the initial caloric gain or loss of the snowpack for a day in calories.

FREWT is the amount of free water being held by the snowpack in inches.

ONTRS is the volume of intercepted snow remaining on the canopy.

14. PRWQV, RCHRG, (SMTMI(I), I=1,3)

FORMAT: 5F10.5

PRWQV is the predicted water equivalent of the snowpack in inches.

RCHRG is the recharge requirements or soil mantle storage deficit.

SMTM1(I) is the surface or air temperature of the snowpack in degrees Fahrenheit.

SMTM1(2) is the center temperature of the snowpack in degrees Fahrenheit.

SMTM1(3) is the ground or bottom temperature of the snowpack in degrees Fahrenheit.

The above inputs, 1 through 14, must all be repeated for each plane of each of the NUMB units involved in the simulation.

File: SOIxxxx is a permanent file, which is used as TAPE7 by the FORTRAN program HYDROL.

The inputs on the file SOIxxxx are; for horizon 1:

1. ST

FORMAT: 20A4

ST identifies the simulation and is the title used to describe the data and the horizon or soil layer.

2. N, NC, RESWA, NALT

FORMAT: I2, 8X, I2, 8X, F6.3, 32X, I1

N is the number of points in capillary tension-soil moisture content curve (experimentally measured).

NC is the number of points to be in the generated soil data curves.

RESWA is the residual water which is not drained out by gravity.

NALT is the management alternative number ($1 \leq NALT \leq 4$).

3. SURTE, DENWA, VISWA, XTEMP, GRAVT

FORMAT: F6.2, 4X, F5.3, 5X, F9.6, 1X, F4.1, 6X, F5.1

SURTE is the surface tension of water in dynes per centimeter.

DENWA is the density of water in grams per cubic centimeters.

VISWA is the kinematic viscosity of water in centimeters squared per second.

XTEMP is the temperature at which the soil tension data was taken, in degrees celsius.

GRAVT is the gravitional constant in centimeters per second squared.

4. EXPOO

FORMAT: F4.2

EXPOO is the exponent used in the relationship for hydraulic conductivity as a function of capillary tension and moisture content.

5. (THSOI(J), J=1,N)

FORMAT: 20F4.3

THSOI is the percent of soil volume occupied by water, and is part of the capillary tension-soil moisture content curve.

6. (DP(J), J=1,N)

FORMAT: 10F6.1

DP is the capillary suction head in centimeters of water corresponding to THSOI in the capillary tension-soil moisture content curve. Items 5 and 6 represent laboratory data.

7. NSED

FORMAT: I3

NSED is the number of points in the sediment size distribution curve.

8. (SIZE(I), PERSZ(I), I=1, NSED)

FORMAT: 2F10.5

SIZE contains the sediment diameters in millimeters, for the sediment distribution curve.

PERSZ is the percentage of the sediment which has a diameter smaller than the corresponding entry in the size array.

For horizon 2, inputs 1 through 6 are repeated, but inputs 7 and 8 are omitted, i.e.,

9. ST is the same variable as in input 1.

10. N, NC, TMAX, SCON, RESWA, NALT

    FORMAT: I2, 8X, I2, 8X, F7.4, 3X, F9.5, 1X, F6.3, 31X, I1

    N, NC, RESWA, NALT are the same variables as in input 2.

    TMAX is the soil porosity.

    SCON is the saturated hydraulic conductivity in centimeters per day.

11. SURTE, DENWA, VISWA, XTEMP, GRAVT are the same variables as in input 3.

12. EXPOO is the same variable as in input 4.

13. (THSOI(J), J=1,N) is the same array as in input 5.

14. (DP(J), J=1,N) is the same array as in input 6.

The above inputs 1 through 14, must all be repeated for each plane of each of the NUMB units involved in the simulation.

File: EDAxxxx is a permanent file, which is used as TAPE31 by the FORTRAN program HYDROL.

The inputs on the file EDAxxxx are:

1. IDUM

   FORMAT: A2

   IDUM is an end-of-file mark (EOF).

2. CASEI

   FORMAT: 20A4

   CASEI identifies the simulation problem and is the title used to describe the environmental data.

3. (LEAP(I), I=1,12), NM

   FORMAT: 13I5

LEAP is an array which indicates whether the month occurred in a leap year. LEAP(I) = 1 if the Ith month occurred in a leap year and LEAP(I) = 0 otherwise (January being the first month).

NM is the number of months being simulated in the current simulation year.

The rest of the file is divided into six parts, and each of these parts consists of thirty six lines. The rest of the data for the first year of simulation are the lines:

4-39. IMO, IDY, RP

FORMAT: 9X, I2, I1, 11F10.7

IMO is the numeric value of the month, where the numeric value of January is 1. The first value of IMO is set equal to MOBEG (the month when simulation begins).

IDY is the line number for the month IMO and takes on the sequential values: 1, 2, and 3. That is, each month has three cards.

RP is the daily precipitation in inches.

40-75. IMO, IDY, IRP

FORMAT: 9X, I2, I1, 11I10

IMO is the same as it is above.

IDY is the same as it is above.

IRP is the multiple day storm indicator. It is set equal to 1 if there is precipitation on both the present day and the following day. It is set equal to 0 otherwise.

76-111. IMO, IDY, RP

FORMAT: 9X, I2, I1, 11F10.7

IMO is the same as it is above.

IDY is the same as it is above.

RP is the total daily solar radiation in langleys per day.

112-147. IMO, IDY, RP

FORMAT: 9X, I2, I1, 11F10.7

IMO is the same as it is above.

IDY is the same as it is above.

RP is the average vapor pressure ± 4 hours from solar noon in millibars.

148-183. IMO, IDY, RP

FORMAT: 9X, I2, I1, 11F10.7

IMO is the same as it is above.

IDY is the same as it is above.

RP is the minimum air temperature ±4 hours from solar noon in degrees Fahrenheit.

184-219. IMO, IDY, RP

FORMAT: 9X, I2, I1, 11F10.7

IMO is the same as it is above.

IDY is the same as it is above.

RP is the maximum air temperature ±4 hours from solar noon in degrees Fahrenheit.

The lines (2-219) must all be repeated for each plane of each of the NUMB units involved in the simulation.

All of this set of data is then repeated for each additional year of simulation with the data corresponding to the appropriate year. File: VOIxxxx is a permanent file, which is used as TAPE33 by the FORTRAN program HYDROL.

The inputs on the file VOIxxxx are:

1. IDUM

   FORMAT: A2

   IDUM is an end-of-file mark (EOF).

2. (DDATE(I), I=1,5)

   FORMAT: 5A4

   DDATE is the calendar description of the storm event, i.e., month, day of the month, and year.

3. NNUMD

FORMAT: I3

NNUMD is the Julian date (1 through 366) of the storm event which corresponds to DDATE.

4. ADJTI

FORMAT: F10.5

ADJTI is the time in minutes between the start of the storm event on the entire watershed and when it reaches the subunit presently being simulated.

5. IRAIN

FORMAT: I3

IRAIN is the numbers of entries in the rainfall hyetograph, or alternatively, one plus the number of intervals in the rainfall hyetograph of the storm.

6. The next IRAIN lines in the set, where let I = 1, IRAIN, are:

RAIN(I), RAINT(I)

FORMAT: 2F10.5

RAIN is the array of the storm rainfall intensities for the rainfall hyetograph in inches per hour.

RAINT is the array of the corresponding times for the rainfall hyetograph for this storm event in minutes. These times are the times at which a given period of constant rainfall ends.

All the lines 2 through 6 are repeated for each storm event of the simulation year on the watershed. Thus, there are NEVNT of these sets of lines, where NEVNT is the number of storms being simulated in a year. All the above information is repeated except for line 1, but after being made plane specific, for each plane of each of the NUMB units involved in the simulation. Then, all the information is repeated for each year of the simulation.

File: F09xxxx is a permanent file which is used as TAPE9 by the FORTRAN program MCHNL.

The inputs on the file F09xxxx are:

1. NPL, NWS, NSEG, NSED, IMAX

   FORMAT: 5I10

   NPL is the number of single planes.

   NWS is the number of watersheds (2 planes and 1 channel).

   NSEG is the number of channels.

   NSED is the number of sediment sizes in the sediment size distribution curve.

   IMAX is the maximum number of iterations allowed in the numerical approximation of the routing.

2. (ISEG(I), (IWS(I,J), J=1,3), (IPL(I,J), J=1,2), (IUP(I,J), J=1,2), ICON(I), I=1, NCH)

   FORMAT: 9I10

   ISEG is the sequential integer assigned to the channel (note: ISEG(I) = I).

   IWS are the watersheds associated with the channel ISEG(I).

   IPL are the planes associated with the channel ISEG(I).

   IUP are the channels which flow into the channel ISEG(I).

   ICON are the upstream connections to the channel ISEG(I).

3. EPS

   FORMAT: F10.0

   EPS is the convergence criterion for the numerical approximation scheme.

File: F10xxxx is a permanent file, which is used as TAPE10 by the FORTRAN program MCHNL.

The inputs on the file F10xxxx are:

1. LINE1

   FORMAT: A2

   LINE1 is a blank line.

2. LINE2

FORMAT: A2

LINE2 is a blank line.

3. SLEN(I), SLOP1(I), WETK(I), POROS(I), SI(I), SW(I), SUC(I)

FORMAT: 7F10.0

SLEN is the length of the plane.

SLOP1 is the slope or inclination of the plane.

WETK is the hydraulic conductivity in the wetted zone in centimeters per hour.

POROS is the porosity of the soil.

SI is the initial saturation or moisture content of the soil.

SW is the final saturation in the wetted zone.

SUC is the capillary suction head in centimeters.

4. XN(I), C(I), T(I)

FORMAT: 3F10.0

XN is Manning's N.

C is Chezy's C.

T is the temperature of the soil in degrees celsius.

5. A1(I), B1(I), A2(I), B2(I), AGB(I), BEX(I), ADF(I), DELTS(I)

FORMAT: 8F10.0

A1 is the coefficient in the area-perimeter relationship (P = A1 * A ** B1).

B1 is the exponent in the area-perimeter relationship (P = A1 * A ** B1).

A2 is the coefficient in the area-top width relationship (W =

A2 * A ** B2).

B2 is the exponent in the area-top width relationship (W = A2 * A ** B2).

AGB is the coefficient in the bed-material-transport equation.

BEX is the exponent in the bed-material-transport equation.

ADF is the runoff detachment coefficient.

DELTS is the critical shear constant.

6. (D(I,J), PF(I,J), J = 1, NSED)

FORMAT: 2F10.0

D contains the sediment diameters in millimeters, for the sediment distribution curve in the channel I.

PF is the percentage of the sediment which has a diameter smaller than the corresponding entry in the D array.

All the above six inputs are repeated for each channel, i.e., I=1, NSEG.

File: QUPxxxx is a permanent file, which is used as TAPE20 by the FORTRAN program MCHNL.

The inputs on the file QUPxxxx are:

1. QCON

FORMAT: F10.0

QCON is the upstream inflow discharge in cubic meters per second.

2. (GBCON(M), M = 1, MM)

FORMAT: 8F10.0

GBCON is the upstream inflow of sediment in cubic meters per meter width of the channel.

There are at most NEVNT * NUM * NSEG such subsets of input on this file for each simulation year. The data is grouped into NEVNT sets, one set for each storm event with runoff, as follows: each set has NUM subsets, one subset for each interval of the hydrograph; and each subset has at most NSEG lines. Each 2 entry subset of the subset corresponds to the appropriate sequential channel, and if ICON(I) = 0, then the Ith 2 entry subset is omitted.

File: OYTxxxx is a permanent file, which is used as TAPE95 = INPUT by the FORTRAN program OXTEMP.

The inputs on the file OYTxxxx are:

1. DZ, DLT, TOTDP

   FORMAT: 3F10.3

   DZ is the space increment for the soil temperature calculation in meters.

   DLT is the time increment for the soil temperature calculation in minutes.

   TOTDP is the total depth of the soil in meters.

2. R1, R3, BA

   FORMAT: 3F10.3

   R1 is the deoxygenation coefficient per minute.

   R3 is the biological oxygen demand constant by sediment uptake per minute.

   BA is the rate of addition of biological oxygen demand in the runoff in grams per liter per minute.

3. THCO, SPGA, SPHE

   FORMAT: 3F10.3

   THCO is the thermal conductivity of the soil in calories per day per meter per degrees celsius.

   SPGA is the specific gravity of the soil.

   SPHE is the specific heat of the soil in calories per gram per degrees celsius.

4. The next NOPL lines are plane specific (see description of file MLIxxxx).

   (TRGRN(I), TRCAN(I), ALT(I), I = 1, NOPL)

   FORMAT: 3F10.2

   TRGRN is the transmissivity of ground cover.

   TRCAN is the transmissivity of canopy.

   ALT is the average height of watershed above mean sea level in meters.

File: NUIxxxx is a permanent file, which is used as TAPE 96 = INPUT by the FORTRAN program NUTRINT.

The inputs on the file NUIxxxx are:

1. TITLE

   FORMAT: 20A4

   TITLE identifies the simulation problem and/or the source of the data.

2. NDX

   FORMAT: I10

   NDX is the number of downslope space increments or sections of the channel.

3. E1, E2, E3, E4, E5, E6, RPA, RKP

   FORMAT: 8F10.5

   E1 is the activation energy for nitrate reduction in kilocalories per mole.

   E2 is the activation energy for ammonium oxidation in kilocalories per mole.

   E3 is the activation energy of adsorption mechanism for ammonium in kilocalories per mole.

   E4 is the activation energy of desorption mechanism for ammonium in kilocalories per mole.

   E5 is the activation energy of adsorption mechanism for ortho-phosphorus in kilocalories per mole.

   E6 is the activation energy of desorption mechanism for ortho-phosphorus in kilocalories per mole.

   RPA is the nitrogen uptake rate by the plants per day.

   RKP is the phosphorous uptake rate by the plants per day.

4. RLAN, RLNA, RSAN, RSNA, RKAS, RKSA, RKPS, RKSP

   FORMAT: 8F10.5

   RLAN is the nitrification rate constant in the litter in kilograms per cubic meter per day.

   RLNA is the denitrification rate constant in the litter per day.

RSAN is the nitrification rate constant in the soil per day.

RSNA is the denitrification rate constant in the soil per day.

RKAS is the adsorption rate constant for ammonium per day.

RKSA is the desorption rate constant for ammonium per day.

RKPS is the adsorption rate constant for ortho-phosphorus per day.

RKSP is the desorption rate constant for ortho-phosphorus per day.

5. RLOM

FORMAT: F10.5

RLOM is the mineralization rate constant for organic phosphorus per day.

6. INK

FORMAT: I10

INK is set equal to 0 if enrichment factor method was used in the nutrient variations subroutine and is set equal to 1 if partition coefficient method was used in the nutrient variations subroutine.

7. (SKP(I,J), J=1,10, I=1,3)

FORMAT: 10F8.1

SKP(1,J) are ten partition coefficient constants associated with the organic nitrogen in upper layer by sediment size fraction and SKP(2,J) are ten partition coefficient constants associated with the organic nitrogen in lower layer and SKP(3,J) are ten partition coefficient constants associated with ammonium in soil.

8. (SKPP(I,J), J=1,10, I=1,3)

FORMAT: 10F8.1

SKPP(1,J) are ten partition coefficient constants associated with the organic phosphate to upper layer by sediment size fraction and SKPP(2,J) are ten partition coefficient constants associated with the organic phosphate in lower layer SKPP(3,J) are ten partition coefficient constants associated with the inorganic phosphate in soil.

9. The remainder of the file is grouped into NOPL sets, one set for each plane.

A. IND

FORMAT: I10

IND is set equal to 0 if no litter layer was considered in the model simulation and is set equal to 1 if a litter layer was considered in the model simulation.

B. RLP, RLPL, RSPL, ROR, RSP

FORMAT: 5F10.5

RLP is the enrichment factor of ortho-phosphorus in runoff.

RLPL is the enrichment factor of ortho-phosphorus for seepage in the litter.

RSPL is the enrichment factor of ortho-phosphorus for deep seepage in the soil.

ROR is the potency factor of organic phosphorus for sediment uptake.

RSP is the potency factor of ortho-phosphorus for sediment uptake.

C. P, ROM, RSN

FORMAT: 3F10.5

P is the precipitation rate of the watershed in millimeters per year.

ROM is the potency factor of organic nitrogen for sediment uptake.

RSN is the potency factor of ammonium for sediment uptake.

D. RSNH, RSNO

FORMAT: 2F10.5

RSNH is the enrichment factor of ammonium for deep seepage in the soil.

RSNO is the enrichment factor of nitrate for deep seepage in the soil.

E. DS, DSL, RH, SGL, SGS

FORMAT: 5F10.5

DS is the thickness of the soil layer or the lower zone of the soil layer in meters.

DSL is the thickness of the litter layer or the upper zone of the soil layer in meters.

RH is the average relative humidity of the air.

SGL is the specific gravity of the litter.

SGS is the specific gravity of the soil.

F. PPTN, PPTA, PPTP, DECAY, F1, F2, FR

FORMAT: 3E10.3, 4F10.4

PPTN is the nitrate input rate to the watershed from precipitation in kilograms per square meter per day.

PPTA is the ammonium input rate to the watershed from precipitation in kilograms per square meter per day.

PPTP is the ortho-phosphorus input rate to the watershed from precipitation in kilograms per square meter per day.

DECAY is the decay rate of the litter per day.

F1 is the nitrogen content of the litter in percent.

F2 is the phosphorus content of the litter in percent.

FR is the fraction of sediment from the litter layer.

G. PERMX

FORMAT: F10.5

PERMX is the intrinsic permeability of the soil in square centimeters.

File: BNKxxxx is a permanent file, which is used as TAPE49 by the FORTRAN program SBEROS.

The inputs on the file BNKxxxx are:

1. SGRA

FORMAT: F10.7

SGRA is the specific gravity of the bank material.

2. The rest of the file is grouped into NSEG sets, where NSEG is the number of channels.

   A. PORO, D10B, D16K, D50K, D84K

      FORMAT: 5F10.7

      PORO is the porosity of the bank material.

      D10B is the diameter for which 10 percent of the bed material is finer in millimeters.

      D16K is the diameter for which 16 percent of the bank material is finer in millimeters.

      D50K is the diameter for which 50 percent of the bank material is finer in millimeters.

      D84K is the diameter for which 84 percent of the bank material is finer in millimeters.

   B. The channels are broken up into NDX (set internally to five in MCHNL) sections. The next NDX lines are section specific for the channel. They each contain:

      ACON, BCON, RLEN

      FORMAT: 3F15.5

      ACON is the coefficient in the relationship between channel width and water discharge (W = A * Q ** B).

      BCON is the exponent in the relationship between channel width and water discharge (W = A * Q ** B).

      RLEN is the reach length of the section in kilometers.

File: INLxxxx is a permanent file, which is used as TAPE5 by the FORTRAN program RILL.

The inputs on the file INLxxxx are:

1. NPL

   FORMAT: I10

   NPL is the number of planes (NPL = NOPL, see description of file MLIxxxx).

2. The rest of the file is grouped into NPL sets.

A. MODE

FORMAT: I1

MODE is set equal to 0 whenever rill flow behaves like laminar flow, and is set equal to 1 whenever rill flow behaves like turbulent flow.

B. ACON, D84F, ANGL, PEAKE

FORMAT: 4F10.0

ACON is the coefficient in the area-perimeter relationship (P = ACON * A ** .5).

D84F is the diameter for which 84 percent of the sediment is finer in millimeters.

ANGL is the angle of friction in degrees. If it is unknown, it must be set equal to 0.

PEAKE is the peak excess rainfall intensity of historical record that determined the size of the existing rills in centimeters per hour.

C. This line of input depends upon the value of MODE.

When MODE is set equal to 0, the line is:

XKIC

FORMAT: F10.0

XKIC is the number K1 in the relationship:
(F = K1/Reynolds Number)

When MODE is set equal to 1, the line is:

FDAR

FORMAT: F10.0

FDAR is the Darcy-Weisbach F (Turbulent Flow).

File: GOAxxxx is a permanent file, which is used as TAPE42 by the FORTRAN program GOALSUM.

The inputs on the file GOAxxxx are:

1. (PTOTS(JJ), JJ = 1,7)

FORMAT: 1X, G40.10

PTOTS(1) is the total water yield for all planes during the simulation in centimeters.

PTOTS(2) is the total sediment yield for all planes during the simulation in kilograms.

PTOTS(3) is the total dissolved oxygen for all planes during the simulation in milligrams per liter.

PTOTS(4) is the total temperature loading for all planes during the simulation in kilojoules.

PTOTS(5) is the total nitrogen yield for all planes during the simulation in kilograms.

PTOTS(6) is the total phosphorus yield for all planes during the simulation in kilograms.

PTOTS(7) is the total litter loading for all planes during the simulation in kilograms.

The user must initialize all seven lines of input to a space followed by a real zero. From then on, the FORTRAN program GOALSUM rewrites TAPE42 at the end of each simulation year.

File: MANxxxx is a permanent file, which is used as TAPE51 by the FORTRAN programs HYDROL, NUTRINT, and RILL. If NY is the number of years being simulated, then this file contains NY sets, each set corresponding to a year of simulation. Each set in the file MANxxxx contains the following data.

The inputs on the file, which are read by HYDROL, are:

1. IDUM

   FORMAT: A2

   IDUM is an end-of-file mark (EOF).

2. This portion of the file is grouped into NOPL subsets (see description of file MLIxxxx).

   A. NCAN, NCAN1

      FORMAT: 2I2

      NCAN is the number of entries in the canopy leaf index function.

NCAN1 is the number of entries in the watershed coverage by canopy function (NCAN1 = 1 or 3).

B. (CANLI(I), I = 1, NCAN)

FORMAT: 8F10.5

CANLI is the array of canopy leaf index values.

C. (CANLO(I), I = 1, NCAN)

FORMAT: 8F10.5

CANLO is the time array which corresponds to CANLI, in Julian days.

D. ALBVE, CANON, CANOF, SIMIN, SIMAX

FORMAT: 5G10.3

ALBVE is the albedo of the vegetation.

CANON is the Julian day number at which the canopy vegetation has emerged fifty percent.

CANOF is the Julian day number at which fifty percent of the canopy vegetation has died.

SIMIN is the maximum interception storage during the winter in centimeters.

SIMAX is the maximum interception storage during the summer in centimeters.

E. If NCAN1 = 3, CCOV(1), CCOV(2), CCOVT(1), CCOVT(2) if NCAN1 = 1, CCOV(1).

FORMAT: 4F10.5

CCOV is the array containing the percent of the watershed covered by canopy.

CCOVT is the time array which corresponds to CCOV, in Julian days.

F. GRNCO

FORMAT: F10.5

GRNCO is the ground cover density.

G. TMAX, SCON

FORMAT: 2F10.5

TMAX is the soil porosity.

SCON is the saturated hydraulic conductivity in centimeters per day.

The inputs on the file, which are read by NUTRINT, are:

3. IDUM

FORMAT: A2

IDUM is an end-of-file mark (EOF).

4. This portion of the file is grouped into NOPL subsets (see description of file MLIxxxx).

A. RLIT

FORMAT: F10.5

RLIT is the litter input to the litter layer in kilograms per hectare per year.

B. NUMCH

FORMAT: I10

NUMCH is the number of times nutrient concentrations change due to management practices.

C. If NUMCH is greater than 0, the file contains

(i) (NDACH(I), I = 1, NUMCH)

FORMAT: 8I10

NDACH is the array containing the number of days since the beginning of the simulation year when the nutrient concentration changes occur.

(ii) Next, there are NUMCH subsets which consist of the inputs:

(a) (XS(I), I = 1, 6), (XS(I), I = 8,10)

FORMAT: 8F10.5

(b) (XT(I), I = 1, 4), (XT(I), I = 6,7)

FORMAT: 8F10.5

XS and XT are the same arrays as in the description of the file INIxxxx.

The inputs on the file, which are read by RILL, are:

5. IDUM

   FORMAT: A2

   IDUM is an end-of-file mark (EOF).

6. This portion of the file is grouped into NPL subsets (see description of file INLxxxx).

   FLITR

   FORMAT: F10.0

   FLITR is the amount of forest litter production in kilograms per square meter per year.

FILE: SNOxxxx is a permanent file, which is used as TAPE85 by the FORTRAN program HYDROL.

The inputs on the file SNOxxxx are:

1. NSLAS, SLAT

   FORMAT: I10, F10.4

   NSLAS is the number of points in the slope-aspect correction factors of incoming radiation.

   SLAT is the latitude of the watershed in degrees.

2. SADAT(I), I = 1, NSLAS

   FORMAT: 8F10.4

   SADAT is the array of the JULIAN days of the slope-aspect radiation correction function.

3. DATIS

   FORMAT: F10.4

   DATIS is the JULIAN day when the snowpack must be isothermal.

4. LSTUS, NDYSN

   FORMAT: 2I10

   LSTUS an indicator to determine in which reflectivity phase the snowpack is, accumulation or melt.

   NDYSN is the number of days since new snow has fallen.

5. ETDAY(I), I = 1,12

ETDAY is the potential evapotranspiration, as computed by the Hamon method, for each month of the year, in inches.

PROGRAM CREATED FILES

There are forty-four input files which are program created. They are in order of description: TUMxxxx, UMIxxxx, RUNxxxx, RAOxxxx, RAIxxxx, EX1xxxx, EXCxxxx, GEOxxxx, CONxxxx, TAPE15, TA7xxxx, TA8xxxx, MCIxxxx, TAPE3, TAPE12, TAPE4, TAPE13, ALOxxxx, TAPE91, TAPE92, AL1xxxx, AL2xxxx, AL3xxxx, AL4xxxx, ALSxxxx, TMNxxxx, NGExxxx, MOIxxxx, VOLxxxx, SDMxxxx, SEDxxxx, OXHxxxx, OXCxxxx, QPKxxxx, LITxxxx, NUTxxxx, OXTxxxx, WSMxxxx, SBExxxx, SSMxxxx, ST1xxxx, ST2xxxx, ST3xxxx, and ST4xxxx. Note that the files EX1xxxx, RAOxxxx, and SDMxxxx are transformed, respectively, into the files EXCxxxx, RAIxxxx, and SEDxxxx by the system routine SORTMRG from the directions on the file SORTFIL. In addition, the files TUMxxxx and RUNxxxx are also transformed by the system routine SORTMRG from the directions on the file SORTFIL from a spatial arrangement of data to a temporal arrangement. Then, the FORTRAN program combines the information on the files TUMxxxx and UMIxxxx onto the file UMIxxxx. Then, the FORTRAN program EXMIN examines each storm with runoff on the basis of the planear area weighted average runoff. Then, EXMIN removes those storms which are below the threshold level of runoff (set internally) from the files: EXCxxxx, RAIxxxx, RUNxxxx and UMIxxxx. EXMIN also rewrites the file VOLxxxx.

File: TUMxxxx is a permanent file, which is used as TAPE 66 by the FORTRAN program FMULTIN. First, however, TUMxxxx is created by the FORTRAN program HYDROL, and then the data on the file TUMxxxx is regrouped from a spatial arrangement to a temporal arrangement.

The data on the file TUMxxxx are:

1. NEVNT * NOPL lines which are storm specific, where NEVNT is the number of storm events with runoff on the watershed and NOPL is the number of planes, they contain:

   ISTAT, ISTOR, EXTNE, EXTN2, TLRIO

   ISTAT is the number of the subplane, and it is used by the system routine SORTMRG for sorting the file.

   ISTOR is the sequential number for the storms with runoff, and it is used by the system routine SORTMRG for sorting the file.

   EXTNE is the beginning time for runoff for the storm on the plane in minutes.

   EXTN2 is the final time for runoff for the storm on the plane, in minutes.

   TLRIO is the time of ponding since the beginning of rain, in minutes.

File: UMIxxxx is a permanent file, which is used as TAPE65 by the FORTRAN program FMULTIN, as TAPE7 by the FORTRAN program EXMIN, and as TAPE5 = INPUT by the FORTRAN program MULT. UMIxxxx is created by the FORTRAN program HYDROL, added to by the FORTRAN program FMULTIN, and modified by the FORTRAN program EXMIN.

The data on the file UMIxxxx are:

1. JK

   FORMAT: I2

   JK indicates the method the FORTRAN program MULT examines the file EXCxxxx, and is the only piece of data on the file input to the FORTRAN program FMULTIN.
   (JK is set equal to 4).

2. NEVNT * NOPL lines which are storm specific, where NEVNT is the number of storm events with runoff on the watershed, and NOPL is the number of planes. There are NEVNT sets with NOPL lines in a set, they contain:

EXTNE, FT

FORMAT: 2(1X, F19.10)

EXTNE is the beginning time for runoff for the storm on the plane, in minutes, the same value as in file TUMxxxx.

FT is the final time for runoff for the storm on the plane, in minutes.

3. RMORE

FORMAT: A3

RMORE indicates if the file EXCxxxx should be examined further. (RMORE is set to 2HNO).

File: RUNxxxx is a permanent file, which is used as TAPE5 by the FORTRAN program EXMIN, and as TAPE3 by the FORTRAN program OXTEMP. RUNxxxx is created by the FORTRAN program HYDROL, and sorted from a spatial to a temporal arrangement, and is modified by the FORTRAN program EXMIN.

The inputs on the file RUNxxxx are:

1. ISTAT, ISTOR, TOTVL, ELEN1, ELEN2, TA1, TA2, TW, STIME, CANCV, GRNCV

FORMAT: UNFORMATTED

ISTAT is the number of the subplane, and it is used by the system routine SORTMRG for sorting the file.

ISTOR is the sequential number for the storms with runoff, and it is used by the system routine SORTMRG for sorting the file.

TOTVL is the amount of runoff on the plane due to the storm in centimeters.

ELEN1 is the solar radiation for the previous day in langleys per day.

ELEN2 is the solar radiation for the present day (the day of the storm) in langleys per day.

TA1 is the temperature on the previous day in degrees celsius.

TA2 is the temperature on the present day in degrees celsius.

TW is the surface water temperature in degrees celsius.

STIME is the solar radiated period in hours.

CANCV is the canopy cover index.

GRNCV is the same variable as GRNCO in file MANxxxx.

The number of storms on the first plane is NSTOM. There are NOPL * NSTOM lines on this file.

File: RAOxxxx is a permanent file, which is created by the FORTRAN program HYDROL. The data on the file RAOxxxx is arranged spatially. RAOxxxx is used as TAPE1 by the system SORTMRG routine and the file SORTFIL.

The data on the file RAOxxxx are divided into NOPL sets (see description of file MLIxxxx) with NEVNT (the number of storm events with minimum runoff) lines in each set.

Each line contains:

1. ISTAT, ISTOR, NRAIN, T, (RAIN(I), RAINT(I), I = 1, NRAIN)

   FORMAT: UNFORMATTED

   ISTAT is the same variable as in the file RUNxxxx.

   ISTOR is the same variable as in the file RUNxxxx.

   NRAIN is the same as IRAIN in vile VOIxxxx for a one-day storm. It is the sum of all of the IRAIN's for a multiple-day storm.

   T is the current temperature in degrees celsius.

   RAIN is the same variable as in the file VOIxxxx.

   RAINT is the same variable as in the file VOIxxxx.

File: RAIxxxx is a permanent file, which is used as TAPE3 by the FORTRAN program EXMIN and as TAPE2 by the FORTRAN program MULT. RAIxxxx is similar to the file RAOxxxx but with the data having a temporal arrangement.

The data on the file RAIxxxx are divided into NEVNT (the number of storm events with runoff) sets with NOPL (see description of MLIxxxx) lines in each set. Each line contains:

1. ISTAT, ISTOR, NRAIN, T, (RAIN(I), RAINT(I), I = 1, NRAIN)

   FORMAT: UNFORMATTED

   ISTAT is the same variable as in the file RUNxxxx.

   ISTOR is the same variable as in the file RUNxxxx.

   NRAIN is the same variable as in the file RAOxxxx.

   T is the current temperature in degrees celsius.

   RAIN is the same variable as in the file VOIxxxx.

   RAINT is the same variable as in the file VOIxxxx.

File: EX1xxxx is a permanent file, which is used as TAPE8 by the FORTRAN program RILL, and is created by the FORTRAN program HYDROL. EX1xxxx is also used as TAPE1 by the system SORTMRG routine and the file SORTFIL.

The data on the file EX1xxxx is arranged into NOPL sets (see description of file MLIxxxx) with NEVNT lines in each set (the number of storms with runoff). Each line contains:

1. ISTAT, ISTOR, NUMDA, (DATE(I), I=1,5), TOTVL, K, (EX(I), EXTIM(I), I=1,K), TP, KTP, GRNCV, CANCV

   FORMAT: UNFORMATTED

   ISTAT is the same as in the file RUNxxxx.

   ISTOR is the same variable as in the file RUNxxxx.

   NUMDA is the same as NNUMD in the file VOIxxxx for a one-day storm and is the NNUMD of the first day of the multiple day storm.

   DATE is the same as DDATE in the file VOIxxxx for a one day storm and is the DDATE of the first day of the multiple day storm.

   TOTVL is the same as in file RUNxxxx.

K is the number of entries in the hydrograph.

EX is the array of runoff intensities in centimeters.

EXTIM is the time array associated with the array EX in the hydrograph in minutes.

TP is the time of ponding in minutes from the beginning of throughfall.

KTP is the index in the hyetograph which corresponds to TP.

GRNCV is the same as in the file MANxxxx.

CANCV is the same as in the file RUNxxxx.

File: EXCxxxx is a permanent file, which is used as TAPE1 by the FORTRAN program EXMIN and as TAPE16 by the FORTRAN program MULT. EXCxxxx is similar to the file EX1xxxx but the data has a temporal arrangement, and is modified by the program EXMIN.

The data on the file EXCxxxx is grouped into NEVNT sets, one set for each storm with minimum runoff, with the ith set corresponding to the ith storm. Each such set has NOPL lines (see description of file MLIxxxx). Each line contains:

1. ISTAT, ISTOR, NUMDA, (DATE(I), I=1,5), TOTVL, K, (E(I), EXTIM(I), I=1,K), TP, KTP, GRNCO(I), CANCO(I)

   FORMAT: UNFORMATTED

   ISTAT is the same as in the file RUNxxxx.

   ISTOR is the same variable as in the file RUNxxxx.

   NUMDA is the same as in file EXIxxxx.

   DDATE is the same as in file EXIxxxx.

   TOTVL is the same as in file RUNxxxx.

   K is the same as in the file EX1xxxx.

   E is the same as in the file EX1xxxx.

   EXTIM is the same as in the file EX1xxxx.

TP is the same as in the file EX1xxxx.

KTP is the same as in the file EX1xxxx.

GRNCO is the same as in the file MANxxxx.

CANCO is the same as in the file RUNxxxx.

File: GEOxxxx is a permanent file, which is used as TAPE1 by the FORTRAN program MULT, and is created by the FORTRAN program HYDROL.

The data on the file GEOxxxx are divided into NUMB (see description of file MLIxxxx) sets, each set containing:

1. IPLAN

   FORMAT: I10

   IPLAN is set equal to 1 if the subunit is a single plane, and equal to 2 if the subunit is a watershed.

2. IPLAN subsets, where let J = 1, IPLAN, of:

   A. POROS(J)

      FORMAT: F10.0

      POROS is the porosity of the soil.

   B. SLOPE(J), SLLGT(J)

      FORMAT: 2F10.0

      SLOPE is the same variable as in the file PARxxxx.

      SLLGT is the same variable as in the file PARxxxx.

   C. SLOPE(3), SLLGT(3)

      FORMAT: 2F10.0

      Both SLOPE(3) and SLLGT(3) are the same as in the file PARxxxx.

   D. C1, XN, A1, B1

      FORMAT: 4F10.0

      C1, XN, A1, B1 are the same as in the file PARxxxx.

   E. RESIS, RDETC, EXPOO, FDETC, FDETO, SHIEL, NSED

      FORMAT: 6F10.0, I10

RESIS, RDETC, EXPOO , FDETC, FDETO, and SHIEL are the same variables as in the file PARxxxx. NSED is the same variable as in the file SOIxxxx.

F. Next, there are NSED lines, I = 1, NSED, containing:

SIZE(I), PERSZ(I)

FORMAT: 2E20.5

SIZE and PERSZ are the same arrays as in the file SOIxxxx.

File CONxxxx is a permanent file, which is created by the FORTRAN program HYDROL, and is used as TAPE5 by the FORTRAN program OXTEMP and by the FORTRAN program NUTRINT and as TAPE3 by the FORTRAN program MULT.

The inputs on the file CONxxxx are:

1. NPL, NWS

FORMAT: 2I10

NPL is the number of single planes. See file MLIxxxx.

NWS is the number of watersheds (2 planes and 1 channel). See file MLIxxxx.

From these variables, the total number of planes NOPL is calculated as:

NOPL = 2 * NWS + NPL.

2. The rest of the file is used only by MULT, where the number of subunits NUMP is calculated as:

NUMP = NPL + NWS.

The rest of the file consists of NUMP lines:

ISEG(I), ITYPE(I), IPRNT(I)

FORMAT: 3I10

ISEG is the subunit number, it must be that ISEG(I) = I.

ITYPE is set equal to 1 if the subunit is a single plane and to 2 if it is a watershed.

IPRNT is set equal to a nonegative integer when output is desired from the subunit, and to a negative integer otherwise.

File: TAPE15 (or TISxxxx) is a permanent file, which is created by the FORTRAN program MULT and is used as TAPE15 by the FORTRAN programs MCHNL and USFSORT.

The input on the file TAPE15 is:

1. NEVNT

   FORMAT: 1X, I7

   NEVNT is the number of storm events with runoff which fit the criteria given the program MULT. It is usually the number of storms with minimum amount runoff during the year.

File: TA7xxxx is a permanent file, which is used as TAPE7 by the FORTRAN program USFSORT, and is created by the FORTRAN program MULT.

The data on the file TA7xxxx are divided into NEVNT sets (see description of TAPE15). Each set contains:

1. NPL, NUM1

   FORMAT: 2I10

   NPL is the same variable as in file MLIxxxx.

   NUM1 is the number of entry points in the hydrograph, and is equal to the integral part of (FTIM/DTIM + 1). See the description of the file UMIxxxx.

2. The rest of the data are in NPL subsets, where let I = 1, NPL, with each subset containing:

   A. NSED

      FORMAT: 10X, I10

      NSED is the same as in the file SOIxxxx.

   B. (SARAY(J,I), J = 1, NSED)

      FORMAT: 4G20.10

      SARAY is the array of sediment yields in kilograms.

   C. QT(I)

      FORMAT: 4G20.10

      QT is the total discharge in hectares.

D. (QARAY(J,I), J=1,NUM), where let NUM = NUM1 - 1

FORMAT: 4G20.10

QARAY is the array of resulting discharges in cubic meters per second.

File: TA8xxxx is a permanent file, which is used as TAPE8 by the FORTRAN program USFSORT, and is created by the FORTRAN program MULT.

The data on the file TA8xxxx are divided into NEVNT sets (see description of TAPE15). Each set contains:

1. NWS, NUM1

   FORMAT: 2I10

   NWS is the same variable as in the file MLIxxxx.

   NUM1 is the same variable as in TA7xxxx above.

2. The rest of the data are in NWS subsets, where let I = 1, NWS, with each subset containing:

   A. NSED

      FORMAT: 10X, I10

      NSED is the same variable as in the file SOIxxxx.

   B. (SARAY(J,I), J=1, NSED)

      FORMAT: 4G20.10

   C. QT(I)

      FORMAT: 4G20.10

   D. (QARAY(J,I), I=1,NUM), where let NUM = NUM1 - 1

      FORMAT: 4G20.10

      SARAY, QT, and QARAY are the same arrays as are found on TA7xxxx above.

File: MCIxxxx is a permanent file, which is used as TAPE98 = INPUT by the FORTRAN program MCHNL, and is created by the FORTRAN program MULT.

The inputs on the file MCIxxxx are:

1. DT, FTIM

   FORMAT: 2(1X, F9.2)

   DT is the time increment of the hydrograph in minutes.

   FTIM is the final time of the hydrograph in minutes.

These variables are then used to calculate the number of intervals in the hydrograph (NUM); NUM = integral part of (FTIM/DT + .00001).

This input is repeated for each storm event with minimum runoff. That is, there will be NEVNT lines for each plane on the file.

File: TAPE3 (or T03xxx) is a local file, which is used as TAPE3 by the FORTRAN program MCHNL, and is created by the FORTRAN program USFSORT.

The data on TAPE3 are divided into NEVNT sets. Each set contains:

1. (QT(I), I = 1, NPL)

   FORMAT: 4G20.10

   QT and NPL are the same variables as in TA7xxxx above.

2. The rest of the set is divided into NUM subsets, where let J=1, NUM (see the description of TAPE7). Each subset contains: (QARAY(J,I), I=1, NPL)

   FORMAT: 4G20.10

   QARAY is the same array as in TA7xxxx.

File: TAPE12 (or T12xxxx) is a local file, which is used as TAPE12 by the FORTRAN program MCHNL, and is created by the FORTRAN program USFSORT.

The data on TAPE12 are divided into NEVNT sets. Each set contains:

1. (QT(I), I=1, NWS)

   FORMAT: 4G20.10

   QT and NWS are the same variables as in TA8xxxx above.

2. The rest of the set is divided into NUM subsets, where let J=1, NUM (see the description of TAPE7). Each subset contains: (QARAY(J,I), I=1, NWS)

   FORMAT: 4G20.10

   QARAY is the same array as in TA8xxxx.

File: TAPE4 (or TO4xxxx) is a local file, which is used as TAPE4 by the FORTRAN program MCHNL, and is created by the FORTRAN program USFSORT.

The data on TAPE4 are divided into NEVNT sets. Each set is divided into NPL subsets. Let I = 1, NPL. Each subset contains:

1. (SARAY(J,I), J=1, NSED)

   FORMAT: 4G20.10

   NPL, NSED, AND SARAY are the same variables as described in TA7xxxx.

File: TAPE13 (or T13xxxx) is a local file, which is used as TAPE13 by the FORTRAN program MCHNL, and is created by the FORTRAN program USFSORT.

The data on TAPE13 are divided into NEVNT sets. Each set is divided into NWS subsets. Let I = 1, NWS. Each subset contains:

1. (SARAY(J,I), J=1, NSED)

   FORMAT: 4G20.10

   NWS, NSED, and SARAY are the same variables as described in TA8xxxx.

File: AL0xxxx is a permanent file, which is used as TAPE90 by the FORTRAN program ALTPLOT, and is created by the FORTRAN Program HYDROL.

The data on file TAPE90 are:

1. NALT, JSTAR

   FORMAT: UNFORMATTED

   NALT is the same variable as in the file SOIxxxx.

JSTAR is the Julian date of the first day of simulation.

File: TAPE91 (or AMUxxxx) is a local file, which is used as TAPE91 by the FORTRAN program ALTPLOT, and is created by the FORTRAN program MULT.

The data on file TAPE91 are:

1. There are NEVNT (see description of TAPE15) lines on the file, each line contains:

   J1, NUMDA

   FORMAT: UNFORMATTED

   J1 is the sequential storm number.

   NUMDA is the same variable as in the file EX1xxxx.

2. BTIME

   FORMAT: UNFORMATTED

   BTIME is the interval of time between the start of rainfall and the start of runoff in minutes.

File: TAPE92 (or AMCxxxx) is a local file, which is used as TAPE92 by the FORTRAN program ALTPLOT, and is created by the FORTRAN program MCHNL.

The data on file TAPE92 are:

1. NEVNT

   FORMAT: UNFORMATTED

   NEVNT is the same variable as in the file TAPE15.

2. J2

   FORMAT: UNFORMATTED

   J2 is the sequential storm number.

3. ITC, (TIME(K), QOUT(K), K = 1, ITC)

   FORMAT: UNFORMATTED

   ITC is the number of points in the final runoff hydrograph of the storm.

TIME is the array of times for the hydrograph in minutes.

QOUT is the array of discharge intensities for the hydrograph in cubic meters per second.

File: AL1xxxx is a permanent file, which is used as TAPE1 by the FORTAN progarm PREPLOT, and is created by the FORTRAN program ALTPLOT.

The data on the file AL1xxxx are:

1. JSTAR, NEVNT

   FORMAT: UNFORMATTED

   JSTAR is the same variable as in the file AL0xxxx.

   NEVNT is the same variable as in the file TAPE15.

2. There are NEVNT sets of inputs which contain:

   A. NUMDA, ITC, BTIME

      FORMAT: UNFORMATTED

      NUMDA is the same variable as in the file EX1xxxx.

      ITC is the same variable as in the file TAPE92.

      BTIME is the same variable as in the file TAPE91.

   B. (TIME(K), QOUT(K), K = 1, ITC)

      FORMAT: UNFORMATTED

      TIME and QOUT are the same variables as in the file TAPE92.

3. IDUM

   FORMAT: UNFORMATTED

   IDUM is an end-of-file mark (EOF).

These inputs are repeated for each year of simulations. However, note that if NEVNT is zero for some year, then parts 2 and 3 will be missing for that year.

File: AL2xxxx is a permanent file, which is used as TAPE2 by the FORTRAN program PREPLOT, and is created by the FORTRAN program ALTPLOT.

The data on the file AL2xxxx are:

1. JSTAR, NEVNT

   FORMAT: UNFORMATTED

   JSTAR is the same variable as in the file AL0xxxx.

   NEVNT is the same variable as in the file TAPE15.

2. There are NEVNT sets of inputs which contain:

   A. NUMDA, ITC, BTIME

      FORMAT: UNFORMATTED

      NUMDA is the same variable as in the file EX1xxxx.

      ITC is the same variable as in the file TAPE92.

      BTIME is the same variable as in the file TAPE91.

   B. (TIME(K), QOUT(K), K = 1, ITC)

      FORMAT: UNFORMATTED

      TIME and QOUT are the same variables as in the file TAPE92.

3. IDUM

   FORMAT: UNFORMATTED

   IDUM is an end-of-file mark (EOF).

These inputs are repeated for each year of simulation. However, note that if NEVNT is zero for some year, then parts 2 and 3 will be missing for that year.

File: AL3xxxx is a permanent file, which is used as TAPE3 by the FORTRAN program PREPLOT, and is created by the FORTRAN program ALTPLOT.

The data on the file AL3xxxx are:

1. JSTAR, NEVNT

   FORMAT: UNFORMATTED

   JSTAR is the same variable as in the file AL0xxxx.

   NEVNT is the same variable as in the file TAPE15.

2. There are NEVNT sets of inputs which contain:

A. NUMDA, ITC, BTIME

FORMAT: UNFORMATTED

NUMDA is the same variable as in the file EX1xxxx.

ITC is the same variable as in the file TAPE92.

BTIME is the same variable as in the file TAPE91.

B. (TIME(K), QOUT(K), K = 1, ITC)

FORMAT: UNFORMATTED

TIME and QOUT are the same variables as in the file TAPE92.

3. IDUM

FORMAT: UNFORMATTED

IDUM is an endof-file mark (EOF).

These inputs are repeated for each year of simulation. However, note that if NEVNT is zero for some year, then parts 2 and 3 will be missing for that year.

File: AL4xxxx is a permanent file, which is used as TAPE4 by the FORTRAN program PREPLOT, and is created by the FORTRAN program ALTPLOT.

The data on the file AL4xxxx are:

1. JSTAR, NEVNT

FORMAT: UNFORMATTED

JSTAR is the same variable as in the file AL0xxxx.

NEVNT is the same variable as in the file TAPE15.

2. There are NEVNT sets of inputs which contain:

A. NUMDA, ITC, BTIME

FORMAT: UNFORMATTED

NUMDA is the same variable as in the file EX1xxxx.

ITC is the same variable as in the file TAPE92.

BTIME is the same variable as in the file TAPE91.

B. (TIME(K), QOUT(K), K = 1, ITC)

FORMAT: UNFORMATTED

TIME and QOUT are the same variables as in the file TAPE92.

3. IDUM

FORMAT: UNFORMATTED

IDUM is an end-of-file mark (EOF).

These inputs are repeated for each year of simulation. However, note that if NEVNT is zero for some year, then parts 2 and 3 will be missing for that year.

File: ALSxxxx is a permanent file, which is used as TAPE7 by a plotting package which is specific to a TEKTRONIX plotter, and is created by the FORTRAN program PREPLOT.

The data on the file ALSxxxx are arranged in sets with one set for each storm which exceeds the minimum runoff under any mangement alternative (see description of file SOIxxxx). Each set contains:

1. ((T(I,K), Q(I,K), I = 1, 4), K = 1, ITJJ)

FORMAT: (4(F10.2, F10.3))

T(I,K) is the time in minutes for the Kth interval of the storm's hydrograph under the Ith management alternative.

Q(I,K) is the discharge in cubic meters per second for the Kth interval of the storm's hydrograph under the Ith management alternative.

ITJJ is the maximum number of entries in the storm's hydrographs under all management alternatives.

File: TMNxxxx is a permanent file, which is created by the FORTRAN program HYDROL, and is used as TAPE3 by the FORTRAN program NUTRINT.

The inputs on the file TMNxxxx are grouped into NOPL (see description of file MLIxxxx) sets, each containing:

1. (TEMP(I), I=1, ITCOM), where ITCOM is the number of simulation days.

   FORMAT: UNFORMATTED

   TEMP is an array containing the daily average air temperature ±4 hours from solar noon in degrees celsius for the simulation year on the plane (see description of file EDAxxxx, parts 148 through 183).

File: NGExxxx is a permanent file, which is used as TAPE10 by the FORTRAN program EXMIN, as TAPE6 by the FORTRAN program NUTRINT, and as TAPE7 by the FORTRAN program RILL, NGExxxx is created by the FORTRAN program HYDROL.

The file NGExxxx contains NOPL lines, see description of MLIxxxx. Each line contains:

1. SLEN, WIDTH, SLOP1, PHI, SW, SFC, RIO

   FORMAT: UNFORMATTED

   SLEN is the length of the plane in meters.

   WIDTH is the width of the plane in meters.

   SLOP1 is the slope or inclination of the plane.

   PHI is the porosity of the soil.

   SW is the degree of soil saturation.

   SFC is the same variable as in the file PARxxxx.

   RIO is the number of days in the simulation period.

File: MOIxxxx is a permanent file, which is used as TAPE4 by the FORTRAN program NUTRINT, and is created by the FORTRAN program HYDROL.

The data on the file MOIxxxx are divided into NOPL sets with each set containing RIO lines (see descriptions of files NGExxxx and MLIxxxx). Each line contains:

1. SWC

FORMAT: F10.4

SWC is the soil water content in the top soil layer (see description of file PARxxxx).

File: VOLxxxx is a permanent file, which is used as TAPE13 by the FORTRAN program EXMIN, and as TAPE1 by the FORTRAN program NUTRINT. VOLxxxx is created by the FORTRAN program HYDROL, and is modified by the FORTRAN program EXMIN.

The data on the file VOLxxxx are also divided into NOPL sets with RIO lines (see descriptions of files NGExxxx and MLIxxxx) in each set. Each line contains:

1. NB, TOTVL, FRA

FORMAT: UNFORMATTED

NB is the Julian day number for the day being simulated when used by the FORTRAN program EXMIN, and indicates whether the runoff exceed the minimum for routing when used by the FORTRAN program NUTRINT (NB is set equal to 1).

TOTVL is the same variable as in file RUNxxxx.

FRA is the leaching rate in centimeters per hour.

File: SDMxxxx is a permanent file, which is created by the FORTRAN program MULT. The data on the file SDMxxxx is arranged temporally. SDMxxxx is used as TAPE1 by the system SORTMRG routine and the file SORTFIL.

The records on the file SDMxxxx correspond to the records in the file VOLxxxx where TOTVL is greater than the minimum value used in the FORTRAN program EXMIN. Each record contains:

1. ISTOR, ISTAT, NSED, (SGBB(K), K=1, NSED), (SIZE(K), K=1, NSED)

FORMAT: UNFORMATTED

ISTOR is the same variable as in the file RUNxxxx.

ISTAT is the same variable as in the file RUNxxxx.

NSED is the same variable as in the file SOIxxxx.

SGBB is the array of sediment yields in kilograms.

SIZE is the array of scaled geometrical means of consecutive entries in the SIZE array (see the description of the file SOIxxxx).

File: SEDxxxx is a permanent file, which is used as TAPE2 by the FORTRAN program NUTRINT. SEDxxxx is similar to the file SDMxxxx, but with the data having a spatial arrangement.

The records on SEDxxxx correspond sequentially to the lines in VOLxxxx where TOTVOL is greater than the minimum value used by the FORTRAN program EXMIN. Each record contains:

1. ISTOR, ISTAT, NSED, (SGBB(K), K=1, NSED), (SIZE(K), K=1, NSED)

   FORMAT: UNFORMATTED

   ISTOR is the same variable as in the file RUNxxxx.

   ISTAT is the same variable as in the file RUNxxxx.

   NSED is the same variable as in the file SOIxxxx.

   SGBB is the array of sediment yields in kilograms.

   SIZE is the array of scaled geometrical means of consecutive entries in the SIZE array (see the description of the file SOIxxxx).

File: OXHxxxx is a permanent file, which is used as TAPE4 by the FORTRAN program OXTEMP, and is created by the FORTRAN program MULT.

Each line of the NEVNT * NOPL lines (see descriptions of files TAPE15 and MLIxxxx) contains:

1. DT, IM, (QL(I), I = 1, IM)

   FORMAT: UNFORMATTED

   DT is the time increment for the hydrograph in minutes.

IM is the number of entry points in the hydrograph, $1 \leq IM \leq 200$.

QL is the array of outflow discharges in cubic meters per second per meter.

File: OXCxxxx is a permanent file, which is used as TAPE8 by the FORTRAN program OXTEMP, and is created by the FORTRAN program MULT.

There are NOPL lines, see description of the file MLIxxxx, on the file OXCxxxx. The Ith line of the file OXCxxxx, where I = 1, NOPL, contains:

1. SLOPE(I), SLGTH(I), RESIS(I), SLLG3(I)

   FORMAT: 4F12.5

   SLOPE is the slope or inclination of the plane.

   SLGTH is the length of the plane in meters.

   RESIS is the Darcy-Weisbach resistance factor for the channel.

   SLLG3 is the width of the plane in meters.

File: QPKxxxx is a permanent file, which is used as TAPE50 by the FORTRAN program SBEROS, and is created by the FORTRAN program MCHNL. The inputs on the file QPKxxxx are:

1. I, J, QPEAK(I,J), APEAK(I,J)

   FORMAT: UNFORMATTED

   I is the number of channel in the watershed; I = 1, NSEG.

   See the description of NSEG in F09xxxx.

   J is the section number in the channel I; J = 1, 5. See the description of BNKxxxx, noting that NDX = 5.

   QPEAK(I,J) is the peak discharge of the storm in section J of channel I in cubic meters per second.

   APEAK(I,J) is the discharge cross sectional area of storm in section J of channel I in square meters.

File: LITxxxx is a permanent file, which is used as TAPE43 by the FORTRAN program GOALSUM, and is created by the FORTRAN program RILL.

The data on the file LITxxxx is:

1. TFLOD

   FORMAT: 1X, G30.10

   TFLOD is the total litter production loading in kilograms.

File: NUTxxxx is a permanent file, which is used as TAPE44 by the FORTRAN program GOALSUM, and is created by the FORTRAN program NUTRINT.

The data on the file NUTxxxx are:

1. TRMTN

   FORMAT: 1X, G30.10

   TRMTN is the total nitrogen production in kilograms.

2. TRMTP

   FORMAT: 1X, G30.10

   TRMTP is the total phosphorus production in kilograms.

File: OXTxxxx is a permanent file, which is used as TAPE45 by the FORTRAN program GOALSUM, and is created by the FORTRAN program OXTEMP.

The data on the file OXTxxxx are:

1. TDSXY

   FORMAT: 1X, G30.10

   TDSXY is the total oxygen loading in milligrams.

2. TTMLD

   FORMAT: 1X, G30.10

   TTMLD is the total temperature loading in kilojoules.

File: WSMxxxx is a permanent file, which is used as TAPE46 by the FORTRAN program GOALSUM, and is created by the FORTRAN program HYDROL.

The data on the file WSMxxxx is:

1. PERRU

   FORMAT: 1X, G30.10

   PERRU is the total water yield in centimeters.

File: SBExxxx is a permanent file, which is used as TAPE47 by the FORTRAN program GOALSUM, and is created by the FORTRAN program SBEROS.

The data on the file SBExxxx is:

1. T

   FORMAT: 1X, G30.10

   T is the soil bank erosion in kilograms.

File: SSMxxxx is a permanent file, which is used as TAPE48 by the FORTRAN program GOALSUM, and is created by the FORTRAN program MCHNL.

The data on the file SSMxxxx is:

1. YRSED

   FORMAT: 1X, G30.10

   YRSED is the total sediment yield in kilograms.

File: ST1xxxx is a permanent file, which is created by the FORTRAN program HYDROL for plotting purposes. The data on the file are:

1. DATEJ, SNPRS

   FORMAT: UNFORMATTED

   DATEJ is the JULIAN day of the year.

   SNPRS is the daily soil saturations.

File: ST2xxxx is a permanent file which is created by the FORTRAN program HYDROL for plotting purposes. The data on the file are:

1. DATEJ, SNPRS

   FORMAT: UNFORMATTED

DATEJ is the JULIAN day of the year.

SNPRS is the daily soil saturations.

File: ST3xxxx is a permanent file which is created by the FORTRAN program HYDROL for plotting purposes. The data on the file are:

1. DATEJ, SNPRS

   FORMAT: UNFORMATTED

   DATEJ is the JULIAN day of the year.

   SNPRS is the daily soil saturations.

File: ST4xxxx is a permanent file which is created by the FORTRAN program HYDROL for plotting purposes. The data on the file are:

1. DATEJ, SNPRS

   FORMAT: UNFORMATTED

   DATEJ is the JULIAN day of the year.

   SNPRS is the daily soil saturations.

PROGRAMS AND INPUT FILES

There are thirteen FORTRAN programs: HYDROL, FMULTIN, EXMIN, MULT, USFSORT, MCHNL, ALTPLOT, NUTRINT, OXTEMP, SBEROS, RILL, GOALSUM, and PREPLOT. Six of them (FMULTIN, EXMIN, USFSORT, ALTPLOT, PREPLOT, and GOALSUM) manipulate files and their data in order to prepare the files as inputs to the programs. The other seven files (HYDROL, MULT, MCHNL, NUTRINT, OXTEMP, SBEROS, and RILL) perform data calculations and output the simulation results.

There are eight input files needed by the FORTRAN program HYDROL: PARxxxx as TAPE2, MLIxxxx as TAPE4, SOIxxxx as TAPE7, EDAxxxx as TAPE31, VOIxxxx as TAPE33, MANxxxx as TAPE52, SNOxxxx as TAPE 85 and INIxxxx as TAPE52. All eight files are to be created by the user. After each simulation year, INIxxxx is program created, but must initially be created by the user.

There are two input files needed by the FORTRAN program FMULTIN: TUMxxxx as TAPE66; and UMIxxxx as TAPE65. Both TUMxxxx and UMIxxxx are created by the FORTRAN program HYDROL. In addition, the data on the file TUMxxxx is regrouped from a spatial arrangement of data to a temporal arrangement before it is input to FMULTIN.

There are seven input files needed by the FORTRAN program EXMIN: EXCxxxx as TAPE1, RAIxxxx as TAPE3, RUNxxxx as TAPE5, UMIxxxx as TAPE7, MLIxxxx as TAPE9, NGExxxx as TAPE10, and VOLxxxx as TAPE13. MLIxxxx is to be created by the user. NGExxxx and VOLxxxx are created by the FORTRAN program HYDROL. UMIxxxx is used after it has been rewritten by the FORTRAN program FMULTIN. RAIxxxx and EXCxxxx are regroupings of the files RAOxxxx and EX1xxxx, respectively. The regroupings are from spatial arrangement of data to temporal arrangement of data; RAOxxxx and EX1xxxx are created by the FORTRAN program HYDROL. RUNxxxx is created by the FORTRAN program HYDROL and then its spatial arrangement of data is changed to a temporal arrangement before it is input to EXMIN.

There are five input files needed by the FORTRAN program MULT: GEOxxxx as TAPE1, RAIxxxx as TAPE2, CONxxxx as TAPE3, UMIxxxx as TAPE5 = INPUT and EXCxxxx as TAPE16. GEOxxxx and CONxxxx are created by the FORTRAN program HYDROL. RAIxxxx, UMIxxxx, and EXCxxxx are input to MULT after they have been modified by the FORTRAN program EXMIN.

There are three input files needed by the FORTRAN program USFSORT: TA7xxxx as TAPE7, TA8xxxx as TAPE8, and TAPE15. All three files are created by the FORTRAN program MULT.

There are nine input files needed by the FORTRAN program MCHNL: TAPE3, TAPE4, F09xxxx as TAPE9, F10xxxx as TAPE10, TAPE12, TAPE13,

TAPE15, QUPxxxx as TAPE20, and MCIxxxx as TAPE98 = INPUT. F09xxxx, F10xxxx, and QUPxxxx are to be created by the user. MCIxxxx and TAPE15 are created by the FORTRAN program MULT. TAPE3, TAPE4, TAPE12, and TAPE13 are created by the FORTRAN program USFSORT.

There are three input files needed by the FORTRAN program ALTPLOT: ALOxxxx as TAPE90, TAPE91, and TAPE92. ALOxxxx is created by the FORTRAN program HYDROL. TAPE91 is created by the FORTRAN program MULT, and TAPE92 is created by the FORTRAN program MCHNL.

There are nine input files needed by the FORTRAN program NUTRINT: VOLxxxx as TAPE1, SEDxxxx as TAPE2, TMNxxxx as TAPE3, MOIxxxx as TAPE4, CONxxxx as TAPE5, NGExxxx as TAPE6, MANxxxx as TAPE51, INIxxxx as TAPE52, and NUIxxxx as TAPE96 = INPUT. MANxxxx, INIxxxx, and NUIxxxx are to be created by the user. TMNxxxx, MOIxxxx, CONxxxx, and NGExxxx are created by the FORTRAN program HYDROL. VOLxxxx is created by the FORTRAN program HYDROL and is then modified by the FORTRAN program EXMIN. SEDxxxx is a regrouping of the data on the file SDMxxxx from a temporal arrangement to a spatial arrangement. SDMxxxx is created by the FORTRAN program MULT.

There are five input files needed by the FORTRAN program OXTEMP: RUNxxxx as TAPE3, OXHxxxx as TAPE4, CONxxxx as TAPE5, OXCxxxx as TAPE8, and OYTxxxx as TAPE95 = INPUT. OYTxxxx is to be created by the user. OXCxxxx and OXHxxxx are created by the FORTRAN program MULT. CONxxxx and RUNxxxx are created by the FORTRAN program HYDROL, RUNxxxx is input to OXTEMP after its data has been regrouped from a spatial arrangement to a temporal arrangement.

There are three input files needed by the FORTRAN program SBEROS: BNKxxxx as TAPE49, QPKxxxx as TAPE50, and INIxxxx as TAPE52. BNKxxxx

and INIxxxx are to be created by the user. QPKxxxx is created by the FORTRAN program MCHNL.

There are five input files needed by the FORTRAN program RILL: INLxxxx as TAPE5, NGExxxx as TAPE7, EX1xxxx as TAPE8, MANxxxx as TAPE51, and INIxxxx as TAPE52. INLxxxx, MANxxxx, and INIxxxx are to be created by the user. NGExxxx and EX1xxxx are created by the FORTRAN program HYDROL.

There are seven input files needed by the FORTRAN program GOALSUM: GOAxxxx as TAPE42, LITxxxx as TAPE43, NUTxxxx as TAPE44, OXTxxxx as TAPE45, WSMxxxx as TAPE46, SBExxxx as TAPE47, and SSMxxxx as TAPE48. GOAxxxx is initialized to zero by the user. Then, after each simulation year, GOAxxxx is updated by the FORTRAN program GOALSUM. LITxxxx is created by the FORTRAN program RILL, NUTxxxx by NUTRINT, OXTxxxx by OXTEMP, WSMxxxx by HYDROL, SBExxxx by SBEROS, and SSMxxxx by MCHNL.

There are four input files needed by the FORTRAN program PREPLOT: AL1xxxx as TAPE1, AL2xxxx as TAPE2, AL3xxxx as TAPE3, and AL4xxxx as TAPE4. All four files are created by the FORTRAN program ALTPLOT. Each of the four files contains the final hydrographs for the corresponding management alternative; i.e., AL1xxxx contains the hydrographs for alternative 1, etc. (See NALT in file SOIxxxx).

SORT/MERGE and SORTFIL

SORT/MERGE is a system routine which rearranges data on a file according to the sorting instructions contained in the file SORTFIL. SORTFIL indicates that there are two indicies used in the sorting: STORM and STATION. STORM is the major sorting index, is an integer variable, and is the second piece of information on the input line. STATION is the minor sorting index, is an integer variable, and is the first piece of information on the input line. Both variables are to be arranged in ascending order.

THIS IS FILE MLIXXXX

```
2        1
1        2
2        1
3        1
```

THIS IS FILE INIXXXX

```
13.90     22.80     39.14     39.14     39.14E+00
13.90     22.80     39.14     39.14     39.14E+00
13.90     22.80     39.14     39.14     39.14E+00
13.90     22.80     39.14     39.14     39.14E+00
     0.2    0.0265     0.022     0.646   0.01874    0.0156      0.14    0.0024
   0.002    0.0085       0.0       0.0       0.0       0.0
    0.04     0.009      0.22     0.009     0.004     0.003     0.163        0.
     0.0       0.0       0.0
  84000.
     0.2    0.0265     0.022     0.646   0.01874    0.0156      0.14    0.0024
   0.002    0.0085       0.0       0.0       0.0       0.0
    0.04     0.009      0.22     0.009     0.004     0.003     0.163        0.
     0.0       0.0       0.0
  84000.
     0.2    0.0265     0.022     0.646   0.01874    0.0156      0.14    0.0024
   0.002    0.0085       0.0       0.0       0.0       0.0
    0.04     0.009      0.22     0.009     0.004     0.003     0.163        0.
     0.0       0.0       0.0
  84000.
     0.2    0.0265     0.022     0.646   0.01874    0.0156      0.14    0.0024
   0.002    0.0085       0.0       0.0       0.0       0.0
    0.04     0.009      0.22     0.009     0.004     0.003     0.163        0.
     0.0       0.0       0.0
  84000.
     28.31865          .94690          25.36
     28.31865          .94690          25.36
     28.31865          .94690          25.36
     28.31865          .94690          25.36
     28.31865          .94690          25.36
    16.8
    16.8
    16.8
    16.8
```

THIS IS FILE PARXXXX

```
FOREST MANAGEMENT ALTERNATIVES
 1        0.0        0.0
   50.        60.        103.        103.        103.E+00
  .278        .38        .38         .38         .38E+00
1.0132       .240        2.5        100.E+00
   .12        .01        .66         .34         0.        20.0E+00
        1.         1.         1.         1.         1.
      0.15       0.15       0.03
    356.62       0.07        0.0
    914.40       0.06
      100.       0.00       7.88         .5     20000.
     .0014        2.0      .0001      .0000        .05
       .25        .25      32.00       0.00        0.0       0.00       0.00
      0.00        0.0       0.00       0.00        0.0
FOREST MANAGEMENT ALTERNATIVES
 0        0.0        0.0
   50.        60.        103.        103.        103.E+00
  .278        .38        .38         .38         .38E+00
1.0132       .240        2.5        100.E+00
   .12        .01        .66         .34         0.        20.0E+00
        1.         1.         1.         1.         1.
      0.15       0.15       0.03
    307.24       0.06        0.0
    914.40       0.06
      100.       0.00       7.88         .5     20000.
     .0014        2.0      .0001      .0000        .05
       .25        .25      32.00       0.00        0.0       0.00       0.00
      0.00        0.0       0.00       0.00        0.0
FOREST MANAGEMENT ALTERNATIVES
 0        0.0        0.0
   50.        60.        103.        103.        103.E+00
  .278        .38        .38         .38         .38E+00
1.0132       .240        2.5        100.E+00
   .12        .01        .66         .34         0.        20.0E+00
        1.         1.         1.         1.         1.
      0.15       0.15       0.03
    262.13       0.07        0.0
   1219.20       0.05
     25.38       0.00       7.34         .5     20000.
     .0014        2.0      .0001      .0000        .05
      0.25       0.25      32.00       0.00        0.0       0.00       0.00
      0.00        0.0       0.00       0.00        0.0
FOREST MANAGEMENT ALTERNATIVES
 0        0.0        0.0
   50.        60.        103.        103.        103.E+00
  .278        .38        .38         .38         .38E+00
1.0132       .240        2.5        100.E+00
   .12        .01        .66         .34         0.        20.0E+00
        1.         1.         1.         1.         1.
      0.15       0.15       0.03
    254.05       0.08        0.0
   1219.20       0.05
     25.38       0.00       7.34         .5     20000.
     .0014        2.0      .0001      .0000        .05
       .25        .25      32.00       0.00        0.0       0.00       0.00
      0.00        0.0       0.00       0.00        0.0
```

THIS IS FILE SOIXXXX

```
FOREST MANAGEMENT ALTERNATIVES
 8        50           0.0  MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.287.300.320.325.350.375.500
15000. 5000. 1000.  500.  300.  200.  100.   0.0
  8
     0.005      0.00
     0.010      0.16
     0.100      0.50
     1.000      0.84
     2.000      0.92
     6.000      1.00
    20.000      1.00
    30.000      1.00
FOREST MANAGEMENT: HORIZON 2
 8        50           0.450        2.00    0.0 MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.296.350.370.380.385.425.450
15000. 5000. 1000.  500.  300.  200.  100.   0.0
FOREST MANAGEMENT ALTERNATIVES
 8        50           0.0  MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.287.300.320.325.350.375.500
15000. 5000. 1000.  500.  300.  200.  100.   0.0
  8
     0.005      0.00
     0.010      0.16
     0.100      0.50
     1.000      0.84
     2.000      0.92
     6.000      1.00
    20.000      1.00
    30.000      1.00
FOREST MANAGEMENT: HORIZON 2
 8        50           0.450        2.00    0.0 MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.296.350.370.380.385.425.450
15000. 5000. 1000.  500.  300.  200.  100.   0.0
FOREST MANAGEMENT ALTERNATIVES
 8        50           0.0  MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.287.300.320.325.350.375.500
15000. 5000. 1000.  500.  300.  200.  100.   0.0
  8
     0.005      0.00
     0.010      0.16
     0.100      0.50
     1.000      0.84
     2.000      0.92
     6.000      1.00
    20.000      1.00
    30.000      1.00
FOREST MANAGEMENT: HORIZON 2
 8        50           0.450        2.00    0.0 MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.296.350.370.380.385.425.450
15000. 5000. 1000.  500.  300.  200.  100.   0.0
FOREST MANAGEMENT ALTERNATIVES
 8        50           0.0  MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999        .011380 15.0      980.0
 2.0
.220.287.300.320.325.350.375.500
15000. 5000. 1000.  500.  300.  200.  100.   0.0
```

FILE SOIXXXX (CONTINUED)

```
 8
    0.005      0.00
    0.010      0.16
    0.100      0.50
    1.000      0.84
    2.000      0.92
    6.000      1.00
   20.000      1.00
   30.000      1.00
FOREST MANAGEMENT: HORIZON 2
 8        50          0.450        2.00    0.0 MANAGEMENT ALTERNATIVE NUMBER=1
 73.49     .999       .011380 15.0      980.0
 2.0
.220.296.350.370.380.385.425.450
15000. 5000. 1000.  500.  300.  200.  100.   0.0
```

THIS IS FILE EDAXXXX

```
FOREST MANAGEMENT ALTERNATIVES
   0    0    0    0    1    1    1    1    1    1    1    12
      51 0.0000000 0.0000000 0.0000000 0.0000000  .6389315  .0610650 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      52 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .7978120  .4991070 0.0000000 0.0000000
      53  .7000065  .1286667 0.0000000 0.0000000 0.0000000 3.9099977 0.0000000 0.0000000 0.0000000
      61  .1800023 0.0000000 0.0000000 0.0000000  .2999712 1.4399942 0.0000000  .5199985  .4999950  .2500005 0.0000000
      62 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      63 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      71 0.0000000  .3600003  .2100003  .0500000  .3199977 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      72 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      73 0.0000000  .0500000 0.0000000 0.0000000 0.0000000  .9999992 0.0000000 0.0000000  .6200000
      81 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .2399995 1.0200002  .1600000
      82 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      83  .4800000 0.0000000 0.0000000 0.0000000  .2400000 0.0000000 0.0000000 0.0000000 0.0000000
      91 0.0000000 0.0000000 0.0000000  .7000027  .1499998 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      92 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .0500000  .1000050 0.0000000 0.0000000 0.0000000 0.0000000
      93 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .4500018
     101 0.0000000 0.0000000 0.0000000 0.0000000  .2800005 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
     102 0.0000000  .0700000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
     103  .2900023 0.0000000 0.0000000 0.0000000 1.6750010  .0932720 0.0000000 0.0000000 0.0000000
     111 0.0000000 0.0000000  .1200005 0.0000000 0.0000000 0.0000000  .9499943 0.0000000 0.0000000 0.0000000 0.0000000
     112 0.0000000  .5699990 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .9699952 0.0000000 0.0000000 0.0000000
     113 0.0000000 0.0000000  .8100012 0.0000000 0.0000000 0.0000000 0.0000000  .1799958
     121 0.0000000 0.0000000 0.0000000 0.0000000  .4589690  .4467180 0.0000000  .0800042 0.0000000 0.0000000 0.0000000
     122 0.0000000 0.0000000 2.8795590 1.5555742 0.0000000 0.0000000 0.0000000 0.0000000  .1771415 2.1248610  .0759995
     123 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .7499970
      11 0.0000000 0.0000000  .3500037  .0364000  .3250035  .3711468 1.2655312  .5844800 0.0000000 0.0000000 0.0000000
      12 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000  .4299998 0.0000000  .4999978  .9699978
      13 0.0000000 0.0000000  .0500000  .8999893 0.0000000  .0800025 0.0000000 0.0000000 0.0000000
      21 1.5065072  .4124520 0.0000000 0.0000000 0.0000000  .0700017 0.0000000  .2499817 0.0000000  .0099760 0.0000000
      22 0.0000000 0.0000000 0.0000000  .3999975 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      23 0.0000000 0.0000000 0.0000000  .0800000 0.0000000 0.0000000
      31 0.0000000  .7300047 0.0000000 0.0000000  .2500007  .3999970 0.0000000 0.0000000  .4000002 0.0000000 1.8000000
      32 0.0000000 0.0000000 0.0000000 0.0000000 2.0499952 0.0000000 0.0000000 0.0000000  .3499997 0.0000000 0.0000000
      33 0.0000000  .3499950 0.0000000 0.0000000 0.0000000  .3753597  .0623950 1.8999958 1.2199980
      41 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 1.2946800 2.1053087 0.0000000 0.0000000
      42 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
      43 0.0000000  .9999970  .1999892  .1500020 0.0000000  .4299963 0.0000000 0.0000000
```

Reproduced from best available copy.

FILE EDAXXXX (CONTINUED

51	0	0	0	0	1	0	0	0	0	0	0
52	0	0	0	0	0	0	0	1	0	0	0
53	1	0	0	0	0	0	0	0	0		
61	0	0	0	0	1	0	0	1	1	0	0
62	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0			
71	0	1	1	1	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0		
81	0	0	0	0	0	0	0	-	1	1	0
82	0	0	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0		
91	0	0	0	1	0	0	0	0	0	0	0
92	0	0	0	0	0	1	0	0	0	0	0
93	0	0	0	0	0	0	0	0			
101	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	1	0	0	0	0		
111	0	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0			
121	0	0	0	0	1	0	0	0	0	0	0
122	0	0	1	0	0	0	0	0	1	1	0
123	0	0	0	0	0	0	0	0	0		
11	0	0	1	1	1	1	1	0	0	0	0
12	0	0	0	0	0	0	0	0	0	1	0
13	0	0	1	0	0	0	0	0	0		
21	1	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0					
31	0	0	0	0	1	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	1	1	1	0		
41	0	0	0	0	0	0	0	1	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0
43	0	1	1	0	0	0	0	0			
51	454.430	300.430	344.530	221.450	482.290	440.350	283.580	366.510	422.480	504.420	597.840
52	599.520	619.630	367.220	483.320	503.320	538.200	545.100	518.210	508.080	644.980	629.340
53	278.390	170.780	621.700	674.280	354.910	665.170	637.550	506.240	737.460		
61	709.690	670.220	590.100	700.890	684.310	667.650	639.280	657.340	628.820	763.360	647.310
62	233.420	694.850	537.480	566.960	210.500	432.840	608.470	626.140	579.390	468.210	257.510
63	345.260	397.860	483.360	526.290	526.090	555.070	583.970	490.250			
71	548.250	530.360	529.940	512.020	505.720	447.140	498.870	504.090	503.470	491.270	513.690
72	686.830	636.890	644.520	550.740	561.260	548.840	553.540	592.380	476.580	499.250	489.720
73	591.870	584.710	534.280	533.030	516.820	507.160	505.870	504.560	511.520		
81	501.830	508.680	498.980	505.730	456.890	517.190	477.570	540.950	548.160	519.470	553.400
82	555.920	407.710	451.260	464.560	507.520	446.200	481.860	390.710	507.340	468.290	459.480
83	428.540	209.520	396.070	372.420	384.930	390.620	381.300	231.790	363.610		
91	452.430	394.860	385.530	297.460	345.430	159.840	327.370	382.120	365.830	314.720	294.280
92	310.900	308.970	266.070	298.250	296.280	180.590	172.720	85.760	176.850	182.080	148.460
93	128.130	57.220	201.870	232.830	223.510	184.730	183.200	127.150			
101	236.110	230.060	192.630	229.830	227.710	217.910	204.470	202.470	51.970	58.790	156.380
102	154.740	96.130	179.600	177.610	141.180	129.350	151.390	149.590	124.790	84.330	76.870
103	139.140	121.720	126.270	94.200	98.900	41.380	107.810	100.520	82.070		
111	27.880	79.640	27.040	37.270	86.470	23.210	48.200	84.850	27.000	55.500	78.280
112	67.620	38.950	67.540	55.300	32.590	49.090	35.630	37.050	40.420	41.680	29.230
113	44.020	24.430	11.070	23.570	35.620	24.500	24.080	38.890			
121	29.930	9.820	25.760	31.710	12.490	12.830	25.300	29.970	24.660	14.630	14.470
122	11.930	14.190	23.450	16.300	9.250	9.200	9.160	9.130	9.110	13.650	11.380
123	13.670	9.130	15.110	16.560	13.870	25.120	23.900	21.260	25.670		
11	28.690	20.290	9.770	19.770	12.510	15.220	20.570	26.100	21.190	10.760	8.200
12	8.340	23.750	39.700	19.320	33.970	41.860	18.530	13.210	9.610	15.660	29.910
13	38.580	10.340	40.020	53.630	56.790	64.490	18.110	18.430	56.280		
21	59.650	67.960	54.320	62.760	58.710	64.870	52.740	80.380	73.480	85.690	103.840
22	99.710	109.870	58.670	98.200	96.560	79.550	124.050	138.280	140.110	141.930	120.860

FILE EDAXXXX (CONTINUED)

23	138.910	70.310	108.420	44.570	135.260	49.110					
31	82.480	188.500	87.920	173.970	175.750	135.970	194.520	223.360	112.740	164.810	249.480
32	111.880	181.400	219.570	250.140	70.300	233.470	205.940	63.540	68.310	202.190	281.730
33	314.370	294.660	225.880	330.030	188.600	271.240	236.620	137.390	244.270		
41	329.270	377.950	384.910	382.460	327.690	386.860	413.040	362.190	344.720	370.950	382.690
42	256.430	223.020	378.520	390.350	115.650	353.620	192.840	418.000	465.920	503.940	315.000
43	285.200	479.020	470.480	472.330	432.010	444.220	440.560	452.810			
51	9.340	10.720	10.720	9.800	11.470	11.470	11.470	12.270	10.010	8.710	14.010
52	15.970	19.360	14.010	16.070	15.760	14.200	12.940	11.240	7.050	9.340	10.640
53	15.870	10.360	9.210	8.120	12.770	13.290	14.860	14.200	9.340		
61	9.090	9.410	11.780	11.550	11.940	12.180	11.550	14.380	9.600	9.410	10.640
62	14.010	10.790	10.640	11.160	10.570	9.340	10.150	13.830	15.970	19.600	15.760
63	14.200	13.110	20.620	21.140	19.600	16.710	12.600	9.670			
71	10.720	12.020	13.380	14.860	13.560	11.780	11.010	12.940	15.460	15.260	13.920
72	14.670	10.570	12.600	21.950	20.620	21.950	24.850	19.360	20.620	17.030	14.380
73	14.380	14.010	17.480	19.110	21.280	19.600	20.750	14.010	16.930		
81	19.110	18.400	18.510	18.160	19.600	18.510	15.160	20.620	20.620	19.360	21.950
82	23.360	14.960	17.030	11.470	11.470	10.720	7.050	9.340	10.720	10.720	8.120
83	8.710	14.010	14.010	14.010	11.470	14.010	17.030	13.110	7.050		
91	8.120	7.050	10.720	8.710	12.270	14.960	15.970	20.620	13.110	14.010	17.030
92	14.010	11.470	10.010	8.710	8.120	13.110	17.030	14.670	14.480	17.930	14.960
93	14.010	12.770	13.110	15.970	21.950	20.620	17.030	9.340			
101	13.290	13.920	13.650	9.280	9.150	7.410	8.120	7.680	7.620	6.900	6.800
102	8.300	12.270	9.340	8.710	8.710	8.710	10.010	8.120	8.120	10.720	11.470
103	8.710	7.050	8.710	8.120	7.570	5.970	5.670	5.270	6.100		
111	8.590	10.720	9.800	9.600	8.420	8.180	9.090	8.650	8.960	9.280	8.010
112	8.530	8.900	8.650	7.960	8.960	9.340	8.710	8.120	8.120	7.570	7.050
113	7.570	7.570	8.120	9.340	6.100	7.570	8.120	6.100			
121	6.100	7.050	6.100	3.610	3.610	3.340	1.910	1.750	2.250	2.860	3.340
122	4.890	4.750	3.340	4.790	5.590	6.020	6.020	6.560	6.950	9.340	8.710
123	7.570	8.470	7.050	7.520	7.840	7.050	6.100	6.100	7.050		
11	6.100	6.100	5.970	3.610	4.540	4.440	3.090	3.580	4.540	5.270	5.970
12	6.560	7.570	7.570	7.570	8.010	7.570	7.570	5.930	6.560	6.100	5.670
13	5.270	6.020	5.970	4.540	5.270	5.670	5.510	6.100	5.670		
21	5.270	6.100	7.410	8.070	9.280	6.100	6.100	7.050	9.340	8.650	6.100
22	7.570	6.100	7.570	8.120	8.710	7.050	5.670	5.270	5.270	5.670	5.670
23	6.100	10.010	11.470	9.340	10.010	9.340					
31	7.410	7.570	7.570	8.070	8.710	8.710	8.710	8.120	9.210	8.120	6.560
32	6.950	6.560	6.560	6.560	7.050	6.560	7.570	6.100	6.560	7.050	6.100
33	6.100	7.570	7.570	5.270	7.050	7.730	6.850	8.120	7.460		
41	7.570	7.790	7.680	8.360	8.710	6.560	4.710	6.420	7.100	8.420	8.420
42	10.360	10.940	9.210	7.960	9.670	7.050	6.330	7.840	7.790	8.840	10.150
43	7.570	8.070	9.470	10.290	7.150	6.060	5.970	7.000			
51	45.440	41.660	35.720	29.060	37.880	34.640	33.560	36.260	34.280	38.060	45.800
52	51.200	56.600	65.600	58.300	59.840	60.020	54.800	46.160	37.520	45.800	46.160
53	42.020	30.500	30.880	38.420	39.320	53.360	61.100	48.500	41.480		
61	40.760	42.200	45.620	50.840	56.960	55.700	52.640	52.280	42.020	45.980	51.020
62	38.600	39.500	34.280	37.520	31.040	28.160	41.300	53.360	60.380	60.740	47.420
63	45.620	51.380	56.600	57.140	58.040	51.740	41.300	40.040			
71	46.880	52.460	53.540	54.260	47.600	46.160	50.480	51.380	55.340	52.640	48.680
72	52.820	53.000	60.200	60.200	60.200	60.200	60.200	53.000	51.200	49.040	50.120
73	52.640	62.000	65.060	71.000	71.720	73.880	71.900	70.460	71.360		
81	70.280	65.780	66.860	66.680	64.700	61.460	65.060	58.400	51.200	54.800	56.600
82	58.400	72.800	66.140	61.640	46.520	49.760	50.120	56.600	54.080	51.560	48.320
83	44.540	38.600	47.420	51.020	46.160	54.080	55.520	44.900	42.560		
91	47.600	55.160	57.500	68.480	58.940	47.960	42.200	49.580	58.040	62.180	58.760
92	57.680	51.020	48.860	51.380	49.400	47.780	43.460	39.860	39.500	45.440	40.940
93	38.600	36.080	38.600	44.000	51.200	62.000	53.000	40.400			
101	44.900	45.440	44.540	45.800	41.120	45.440	46.520	42.560	35.000	29.600	29.780
102	37.880	37.160	38.960	36.620	36.080	35.360	40.400	36.080	33.740	35.540	35.540
103	32.840	32.840	33.020	27.620	26.540	16.460	21.140	18.260	24.920		
111	25.640	33.020	31.580	31.400	27.800	26.180	28.880	26.000	26.720	28.700	24.920
112	26.180	27.440	26.360	24.380	28.520	30.320	25.100	26.720	25.820	22.580	22.040
113	23.480	24.200	24.740	30.320	17.900	22.940	26.180	18.800			
121	18.260	26.900	18.080	5.120	5.300	2.600	-4.600	-10.000	1.340	.440	2.780
122	11.780	10.880	3.320	11.060	14.840	16.640	16.640	18.800	20.240	28.340	26.180
123	23.120	18.440	21.860	22.220	23.300	21.140	18.800	19.340	21.500		

Reproduced from best available copy.

FILE EDAXXXX (CONTINUED)

11	17.720	17.000	16.460	6.200	10.340	9.260	2.960	4.220	9.980	13.580	16.460
12	18.800	22.400	22.940	23.120	23.840	22.940	22.940	16.280	19.520	20.060	16.460
13	15.200	16.640	16.460	12.500	14.480	17.540	14.480	17.180	18.080		
21	17.540	20.780	21.860	24.020	27.620	20.960	23.480	26.360	27.980	25.820	24.020
22	22.940	27.260	24.920	27.440	29.600	21.320	24.020	26.180	29.780	35.720	27.620
23	27.980	34.280	33.200	28.160	31.040	28.340					
31	21.860	26.180	23.120	24.020	26.180	27.800	30.500	31.580	27.440	24.380	23.300
32	20.240	20.240	23.300	30.860	21.140	18.800	23.120	17.180	20.600	23.840	26.540
33	31.400	34.820	31.220	24.560	20.960	22.940	24.560	24.200	22.040		
41	23.300	30.500	35.900	38.960	38.780	32.480	39.140	41.840	41.300	43.280	42.920
42	34.100	31.940	32.480	35.360	28.700	20.600	17.900	23.300	29.240	35.000	35.180
43	31.400	38.600	44.540	46.160	36.440	30.680	32.300	38.780			
51	75.440	71.660	65.720	59.060	67.880	64.640	63.560	66.260	64.280	68.060	75.800
52	81.200	86.600	95.600	89.300	89.840	90.020	84.800	76.160	67.520	75.800	76.160
53	72.020	60.500	60.680	68.420	69.320	83.360	91.100	78.500	71.480		
61	70.760	72.200	75.620	80.840	86.960	85.700	82.640	82.280	72.020	75.980	81.020
62	68.600	69.500	64.280	67.520	61.040	58.160	71.300	83.360	90.380	90.740	77.420
63	75.620	81.380	86.600	87.140	88.040	81.740	71.300	70.040			
71	76.880	82.460	83.540	84.260	77.600	76.160	80.480	81.380	85.340	82.640	78.680
72	82.820	83.000	90.200	90.200	90.200	90.200	90.200	83.000	81.200	79.040	80.120
73	82.640	92.000	95.060	101.000	101.720	103.880	101.900	100.460	101.360		
81	100.280	95.780	96.860	96.680	94.700	91.460	95.060	88.400	81.200	84.800	86.600
82	88.400	102.800	96.140	91.640	76.520	79.760	80.120	86.600	84.080	81.560	78.320
83	74.540	68.600	77.420	81.020	76.160	84.080	85.520	74.900	72.560		
91	77.600	85.160	87.500	98.480	88.940	77.960	72.200	79.580	88.040	92.180	88.760
92	87.680	81.020	78.860	81.380	79.400	77.780	73.460	69.860	69.500	75.440	70.940
93	68.600	66.080	68.600	74.000	81.200	92.000	83.000	70.400			
101	74.900	75.440	74.540	75.800	71.120	75.440	76.520	72.560	65.000	59.600	59.780
102	67.880	67.160	68.960	66.620	66.080	65.360	70.400	66.080	63.740	65.540	65.540
103	62.840	62.840	63.020	57.620	56.540	46.460	51.140	48.260	54.920		
111	55.640	63.020	61.580	61.400	57.800	56.180	58.880	56.000	56.720	58.700	54.920
112	56.180	57.440	56.360	54.380	58.520	60.320	55.100	56.720	55.820	52.580	52.040
113	53.480	54.200	54.740	60.320	47.900	52.940	56.180	48.800			
121	48.260	56.900	48.080	35.120	35.300	32.600	25.400	20.000	31.340	30.440	32.780
122	41.780	40.880	33.320	41.060	44.840	46.640	46.640	48.800	50.240	58.340	56.180
123	53.120	48.440	51.860	52.220	53.300	51.140	48.800	49.340	51.500		
11	47.720	47.000	46.460	36.200	40.340	39.260	32.960	34.220	39.980	43.580	46.460
12	48.800	52.400	52.940	53.120	53.840	52.940	52.940	46.280	49.520	50.060	46.460
13	45.200	46.640	46.460	42.500	44.480	47.540	44.480	47.180	48.080		
21	47.540	50.780	51.860	54.020	57.620	50.960	53.480	56.360	57.980	55.820	54.020
22	52.940	57.260	54.920	57.440	59.600	51.320	54.020	56.180	59.780	65.720	57.620
23	57.980	64.280	63.200	58.160	61.040	58.340					
31	51.860	56.180	53.120	54.020	56.180	57.800	60.500	61.580	57.440	54.380	53.300
32	50.240	50.240	53.300	60.860	51.140	48.800	53.120	47.180	50.600	53.840	56.540
33	61.400	64.820	61.220	54.560	50.960	52.940	54.560	54.200	52.040		
41	53.300	60.500	65.900	68.960	68.780	62.480	69.140	71.840	71.300	73.280	72.920
42	64.100	61.940	62.480	65.360	58.700	50.600	47.900	53.300	59.240	65.000	65.180
43	61.400	68.600	74.540	76.160	66.440	60.680	62.300	68.780			

THIS IS FILE VOIXXXX

```
  5 572
126
 000
  6
   0.000001110.00000
    .1076911-9.00000
    .044441230.00000
    .028571272.00000
    .337501352.00000
    .026551440.00000
  5 672
127
 000
  1
    .02655 138.00000
  51972
140
 000
  9
   0.00000 711.00000
    .21509 764.00000
    .00914 961.00000
    .169231000.00000
    .017141035.00000
    .024661108.00000
    .016551398.00000
   1.371431412.00000
    .059601440.00000
  52072
141
 000
  4
    .05960 123.00000
    .08442 199.00000
    .10270 310.00000
    .48000 320.00000
  52372
144
 000
  8
   0.000001209.00000
   3.000001210.00000
   1.015381223.00000
   2.400001230.00000
    .320001245.00000
    .026671380.00000
    .150001384.00000
   0.000001440.00000
  52472
145
 000
  4
   0.00000  52.00000
    .14000  60.00000
    .01500 220.00000
    .10500 260.00000
  52872
149
 000
 35
   0.00000 225.00000
   1.00000 228.00000
   3.00000 232.00000
   1.50000 236.00000
   1.50000 240.00000
    .60000 243.00000
   2.04000 248.00000
```

```
     .42857 255.00000
    2.00000 258.00000
     .75000 262.00000
    3.00000 274.00000
    1.30000 280.00000
     .84000 285.00000
    1.20000 290.00000
     .84000 295.00000
    1.56000 300.00000
    3.00000 303.00000
     .17143 310.00000
    0.00000 425.00000
     .90000 427.00000
    0.000001020.00000
     .750001024.00000
    0.000001065.00000
    2.563641076.00000
     .036731125.00000
    3.000001134.00000
     .500001140.00000
    1.500001144.00000
    0.000001162.00000
    3.750001166.00000
     .428571173.00000
    0.000001220.00000
    1.500001222.00000
    0.000001267.00000
     .247621330.00000
  6 172
153
 000
  4
    0.00000 412.00000
     .04348 481.00000
     .10800 531.00000
     .07742 562.00000
  6 572
157
 000
  7
    0.00000 416.00000
     .05294 450.00000
     .51000 470.00000
     .03158 527.00000
     .00472 781.00000
     .02013 930.00000
    0.000001440.00000
  6 672
158
 000
  8
    0.00000 714.00000
    2.73333 732.00000
    1.30000 738.00000
    2.40000 740.00000
     .93750 756.00000
     .30000 770.00000
     .04337 853.00000
     .90000 855.00000
  6 872
160
 000
 14
    0.00000 825.00000
    1.20000 830.00000
    0.00000 865.00000
     .42857 872.00000
```

FILE VOIXXXX (CONTINUED)

```
186
 000
  7
   0.000001200.00000
    .060001210.00000
    .060001220.00000
    .060001230.00000
    .060001240.00000
    .060001250.00000
   0.000001440.00000
  7 572
187
 000
  9
   0.00000  13.00000
   3.00000  15.00000
   1.00000  18.00000
    .60000  26.00000
    .03529  60.00000
    .18000  70.00000
    .12000  80.00000
    .06000  90.00000
    .12000  95.00000
  72472
206
 000
  3
   0.00000 965.00000
   1.20000 966.00000
    .90000 968.00000
  72872
210
 000
  8
   0.00000 960.00000
    .15000 980.00000
   0.000001064.00000
   2.250001068.00000
    .136361090.00000
   0.000001203.00000
   2.470591220.00000
    .060001270.00000
  73172
213
 000
  6
   0.00000 996.00000
   3.750001000.00000
   2.500001006.00000
    .200001015.00000
    .112501031.00000
    .360001041.00000
  8 972
222
 000
  5
   0.000001227.00000
    .750001235.00000
    .333331244.00000
    .675001252.00000
   0.000001440.00000
  81072
```

FILE VOIXXXX (CONTINUED)

```
 223
  000
   8
    0.000001192.00000
     .150001200.00000
     .240001215.00000
     .020691244.00000
    2.800001250.00000
    3.075001258.00000
    1.200001270.00000
    0.000001440.00000
   81172
 224
  000
   3
    0.00000 410.00000
     .82500 418.00000
     .25000 430.00000
   82372
 236
  000
   4
    0.000001015.00000
    3.960001020.00000
    1.080001025.00000
     .360001035.00000
   82772
 240
  000
   6
    0.00000 990.00000
     .50000 996.00000
     .750001000.00000
     .900001002.00000
     .675001010.00000
     .120001020.00000
   9 472
 248
  000
  20
    0.00000 935.00000
     .30000 945.00000
     .30000 955.00000
     .42857 962.00000
     .48000 967.00000
    1.80000 969.00000
     .06667 987.00000
     .87273 998.00000
     .030001018.00000
     .150001026.00000
     .450001030.00000
    0.000001070.00000
     .360001080.00000
     .054551091.00000
     .266671100.00000
     .120001110.00000
     .060001120.00000
     .240001130.00000
     .045001170.00000
    0.000001440.00000
   9 572
```

FILE VOIXXXX (CONTINUED)

```
249
 000
  8
   0.00000 649.00000
    .10909 660.00000
    .12000 670.00000
    .12000 680.00000
    .25000 692.00000
   0.00000 850.00000
    .12000 860.00000
    .12000 870.00000
  91772
261
 000
  4
   0.00000 659.00000
   2.40000 660.00000
    .60000 661.00000
   0.000001440.00000
  91872
```

THIS IS FILE FO9XXXX

```
  2       1       1       8      100
  1       1       0       0        1       2       0       0       0
0.05
```

THIS IS FILE F10XXXX

```
CHANNEL DATA
   1219.2      .06     7.62      .45      .85     1.00      3.0
      0.0     100.    18.33
    4.000      0.5     7.32      0.5    .0560      1.5  .0000001      .047
     .005    0.000
     .010    0.000
     .100    0.000
    1.000    0.060
    2.000    0.159
    6.000    0.500
   20.000    0.841
   30.000    1.000
```

THIS IS FILE QUPXXXX

(6 blank lines)

THIS IS FILE OYTXXXX

```
0.16764  20.00000   4.19100
0.05000   0.00000   0.00000
28000.0   1.25000   0.21200
   0.10   0.05000    1219.2
   0.10   0.05000    1219.2
   0.10   0.05000    1219.2
   0.10   0.05000    1219.2
```

THIS IS FILE NUIXXXX

```
FOREST MANAGEMENT ALTERNATIVES
      4
   1.02      1.02      2.4       2.4       2.4       2.4     0.0007    0.00007
   0.01      0.40     0.100      0.45       0.2       1.0       2.0       0.1
   0.07
      1
 2412.0   2022.0   1937.0   1095.0   1095.0   1095.0   1095.0   1095.0   1095.0   1095.0
 2412.0   2022.0   1937.0   1095.0   1095.0   1095.0   1095.0   1095.0   1095.0   1095.0
 2412.0   2022.0   1937.0   1095.0   1095.0   1095.0   1095.0   1095.0   1095.0   1095.0
19978.0   7859.0   5467.0   4029.0   2158.0   2158.0   2158.0   2158.0   2158.0   2158.0
19978.0   7859.0   5467.0   4029.0   2158.0   2158.0   2158.0   2158.0   2158.0   2158.0
19978.0   7859.0   5467.0   4029.0   2158.0   2158.0   2158.0   2158.0   2158.0   2158.0
      1
 0.00001   0.00030   0.00030      2.20      5.5
   1250.      2.20       2.9
 0.00060     0.002
     0.5      0.08       68.      1.41      2.65
1.150E-06 1.210E-06 3.425E-08      0.01     0.005     0.003      0.54
 1.29E-10
      1
 0.00001   0.00030   0.00030      2.20      5.5
   1250.      2.20       2.9
 0.00060     0.002
     0.5      0.08       68.      1.41      2.65
1.150E-06 1.210E-06 3.425E-08      0.01     0.005     0.003      0.54
 1.29E-10
      1
```

FILE NUIXXXX (CONTINUED)

```
 0.00001   0.00030   0.00030      2.20      5.5
   1250.      2.20       2.9
 0.00060     0.002
     0.5      0.08       68.       1.41      2.65
1.150E-06 1.210E-06 3.425E-08      0.01     0.005     0.003     0.54
 1.29E-10
       1
 0.00001   0.00030   0.00030      2.20      5.5
   1250.      2.20       2.9
 0.00060     0.002
     0.5      0.08       68.       1.41      2.65
1.150E-06 1.210E-06 3.425E-08      0.01     0.005     0.003     0.54
 1.29E-10
```

THIS IS FILE BNKXXXX

```
2.700
 0.45      0.30       .01       .10       1.0
     6.659            0.4        .24382
     6.659            0.4        .24382
     6.659            0.4        .24382
     6.659            0.4        .24382
     6.659            0.4        .24382
```

THIS IS FILE INLXXXX

```
          4
 0
     10.00      0.35      0.00      3.00
    0.5075
 0
     10.00      0.35      0.00      3.00
    0.5075
 0
     10.00      0.35      0.00      3.00
    0.5075
 0
     10.00      0.35      0.00      3.00
    0.5075
```

THIS IS FILE GOAXXXX

```
0.0000000000
0.0000000000
0.0000000000
0.0000000000
0.0000000000
0.0000000000
0.0000000000
```

THIS IS FILE MANXXXX

```
12 1
     8.5       7.5       7.0       6.8       7.3       9.0      11.2      11.3
    11.2       9.2       9.0       8.8
      1.      32.       60.       91.      121.      152.      182.      213.
     244.     274.      304.      334.
 0.15       121.      273.      0.03      0.13E+00
    0.80
    0.80
    0.50      6.10
12 1
     8.5       7.5       7.0       6.8       7.3       9.0      11.2      11.3
    11.2       9.2       9.0       8.8
      1.      32.       60.       91.      121.      152.      182.      213.
     244.     274.      304.      334.
 0.15       121.      273.      0.03      0.13E+00
    0.80
    0.80
    0.50      6.10
12 1
     8.5       7.5       7.0       6.8       7.3       9.0      11.2      11.3
    11.2       9.2       9.0       8.8
      1.      32.       60.       91.      121.      152.      182.      213.
     244.     274.      304.      334.
 0.15       121.      273.      0.03      0.13E+00
    0.80
    0.80
    0.50      6.10
12 1
     8.5       7.5       7.0       6.8       7.3       9.0      11.2      11.3
    11.2       9.2       9.0       8.8
      1.      32.       60.       91.      121.      152.      182.      213.
     244.     274.      304.      334.
 0.15       121.      273.      0.03      0.13E+00
    0.80
    0.80
    0.50      6.10
   56000.
       0
   56000.
       0
   56000.
       0
   56000.
       0
     5.6
     5.6
     5.6
     5.6
```

THIS IS FILE SNOXXXX

24	45.00						
10.00	23.00	38.00	51.00	66.00	80.00	94.00	109.00
123.00	138.00	152.00	173.00	193.00	208.00	222.00	237.00
252.00	266.00	281.00	295.00	309.00	323.00	337.00	356.00
128.0							
0	0						
.0463	.0558	.0893	.1481	.2314	.3098	.4007	.3308
.2123	.1254	.0665	.0427				

APPENDIX B

MODEL STRUCTURE

INTRODUCTION

Physically based hydrologic simulation programs are usually long and require large amounts of computer memory and execution time. Efficient algorithms and input-output schemes serve to lower these requirements; however, the realities of job scheduling at most computer centers usually require that large programs be given low priorities in the processing system. Therefore, in order to shorten the time between submitting the program and receiving results (turnaround time), the programmer must tailor the model to his particular processing system. In the case of the hydrologic simulation for the generalized planning model, a model structure was adopted that allows short turnaround time but is portable to other computing systems.

MODEL STRUCTURE

As will be seen in subsequent sections, all of the components of this simulation are subdivided into modular subroutines. This structure requires perhaps a few more FORTRAN statements, but it enjoys the advantage of compartmentalizing related phenomena. Compartmentalization not only makes the program more understandable, but allows easy substitution of improved components as they are developed. An example is the layered soil infiltration subroutine of the water balance component. When an infiltration model better suited to the application is developed, it may be easily substituted for the existing routine without modification to the rest of the water balance subprogram. As implied above, in order to improve turnaround time the modular approach was extended into the overall simulation structure. Each component of the simulation is a subprogram containing related subroutines.

The simulation consists of thirteen subprograms, sixteen input files, thirty-seven intermediate or scratch files and nine output files (Table B-1). Figures B.1, B.2, and B.3 illustrate the flow of information through the model. Finally, the interface with the second level GOAL programming model is accomplished through a matrix of simulation outputs which provides the input to the LEVEL-2 GOAL program. Then the user updates the management sensitive input parameters to the simulation, reflecting LEVEL-2 GOAL decisions. A description of the individual subprogram components appears in the following sections. This section will discuss the flow of information through the simulation and required computational sequences. The function of each component appears under the component name in the figures. In addition Table B-2 summarizes the hydrologic, hydraulic, and chemical processes found as subroutines in each subprogram.

INFORMATION FLOW

As may be seen in Figures B.1, B.2, and B.3, the yearly water budget and flux program, HYDROL is one of three central routines in the simulation, the other two being MULT and MCHNL. It must be noted, however, that MULT and MCHNL function as a unit in the simulation. HYDROL simulates interception, infiltration, soil percolation and drainage, evapotranspiration, evaporation, and canopy growth on a daily basis for the simulation period. Input files to this program are as follows:

1. VOIxxxx - rainfall hyetographs of individual storm events

2. EDAxxxx - environmental data; average daily temperature, average vapor pressure, total daily precipitation, total daily insolation, multiple day storm index

3. MLIxxxx - multiple watershed configuration data, index values indicating watershed shape and computational sequence

4. PARxxxx - watershed characteristics, lengths, slopes, cover density, canopy cover density, detachment coefficients

TABLE B-1. COMPOSITION OF SIMULATION

SUBPROGRAMS	INPUT FILES*	OUTPUT FILES*	INTERMEDIATE FILES*		
HYDROL	MANxxxx	PRSxxxx	TUMxxxx	MOIxxxx	TAPE3
FMULTIN	INIxxxx	HYGxxxx	UMIxxxx	ALOxxxx	TAPE4
EXMIN	VOIxxxx	WSMxxxx	GEOxxxx	SDMxxxx	TAPE12
MULT	MLIxxxx	SSMxxxx	RAOxxxx	SEDxxxx	TAPE13
USFSORT	SOIxxxx	NUTxxxx	RAIxxxx	OXCxxxx	TAPE92
MCHNL	EDAxxxx	OXTxxxx	EX1xxxx	OXHxxxx	QPKxxxx
ALPLOT	PARxxxx	SBExxxx	EXCxxxx	MCIxxxx	AL1xxxx
NUTRINT	SNOxxxx	LITxxxx	CONxxxx	TAPE15	AL2xxxx
OXTEMP	F09xxxx	ALSxxxx	RUNxxxx	TA7xxxx	AL3xxxx
SBEROS	F10xxxx		NGExxxx	TA8xxxx	AL4xxxx
RILL	QUPxxxx		VOLxxxx	TAPE91	TMNxxxx
GOALSUM	NUIxxxx		ST1xxxx	ST2xxxx	ST3xxxx
PREPLOT	OYTxxxx			ST4xxxx	
	BNKxxxx				
	INLxxxx				
	GOAxxxx				

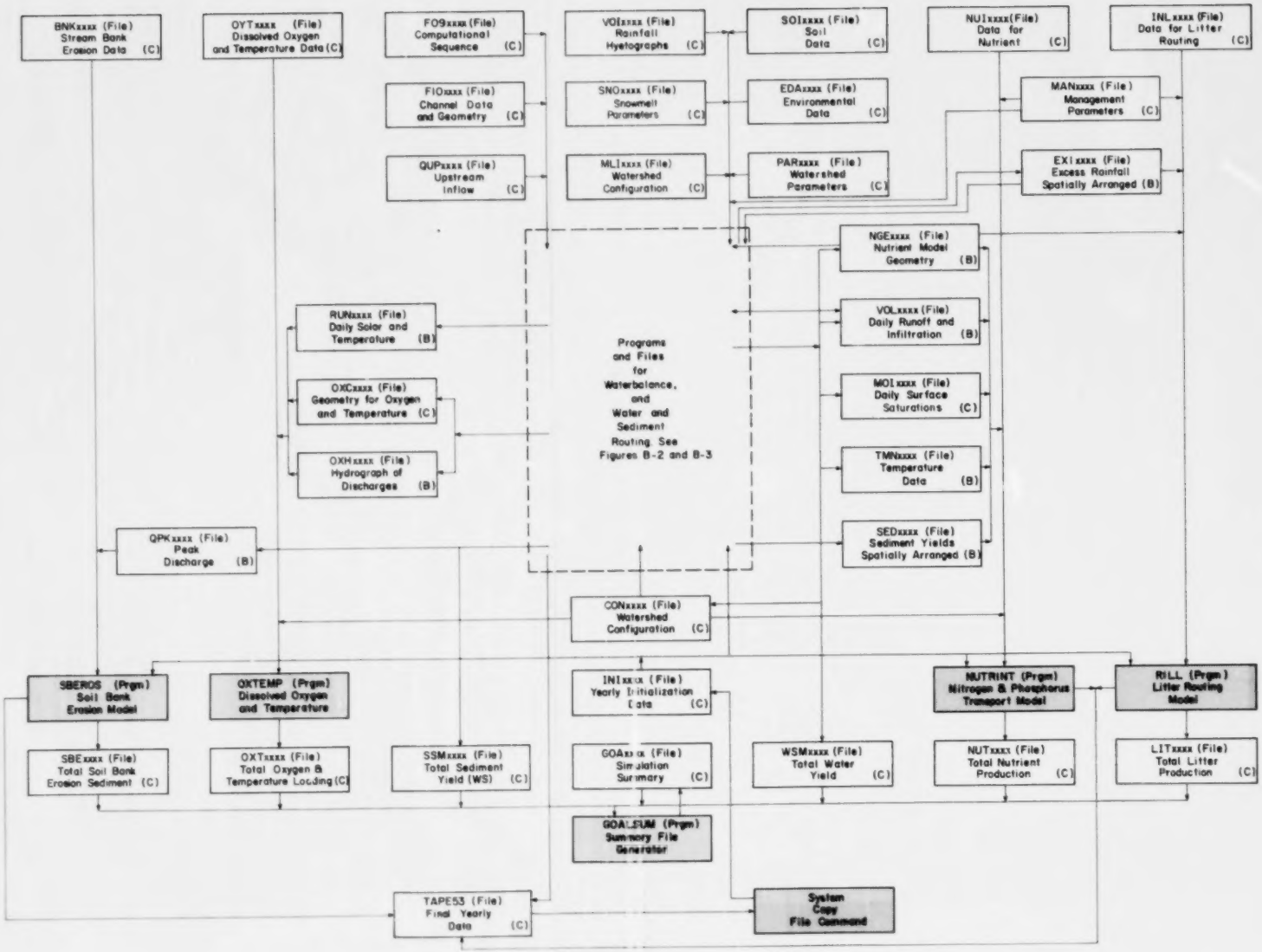


Figure B.1. Generalized Planning Model.

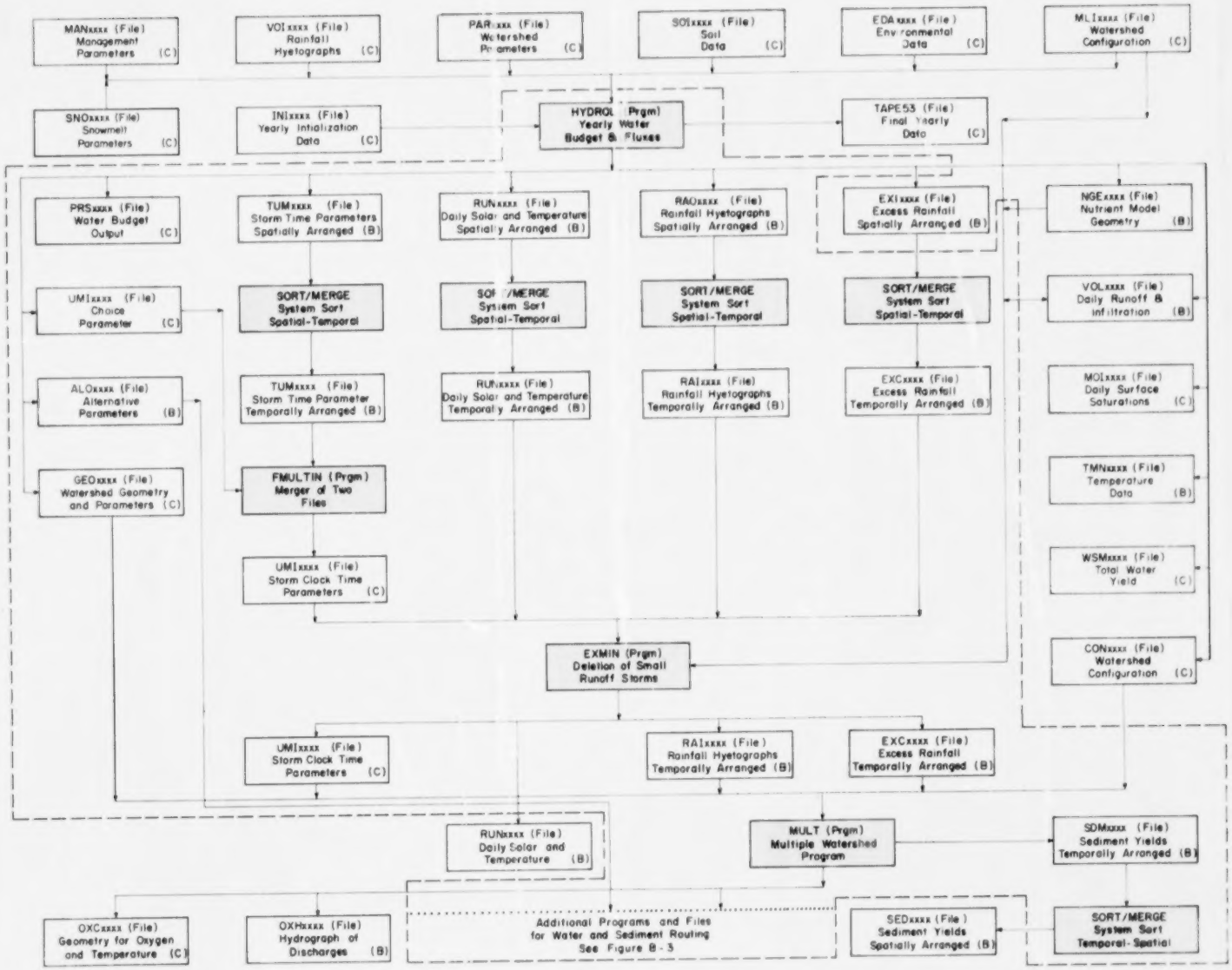


Figure B.2. Water Budget and Flux.

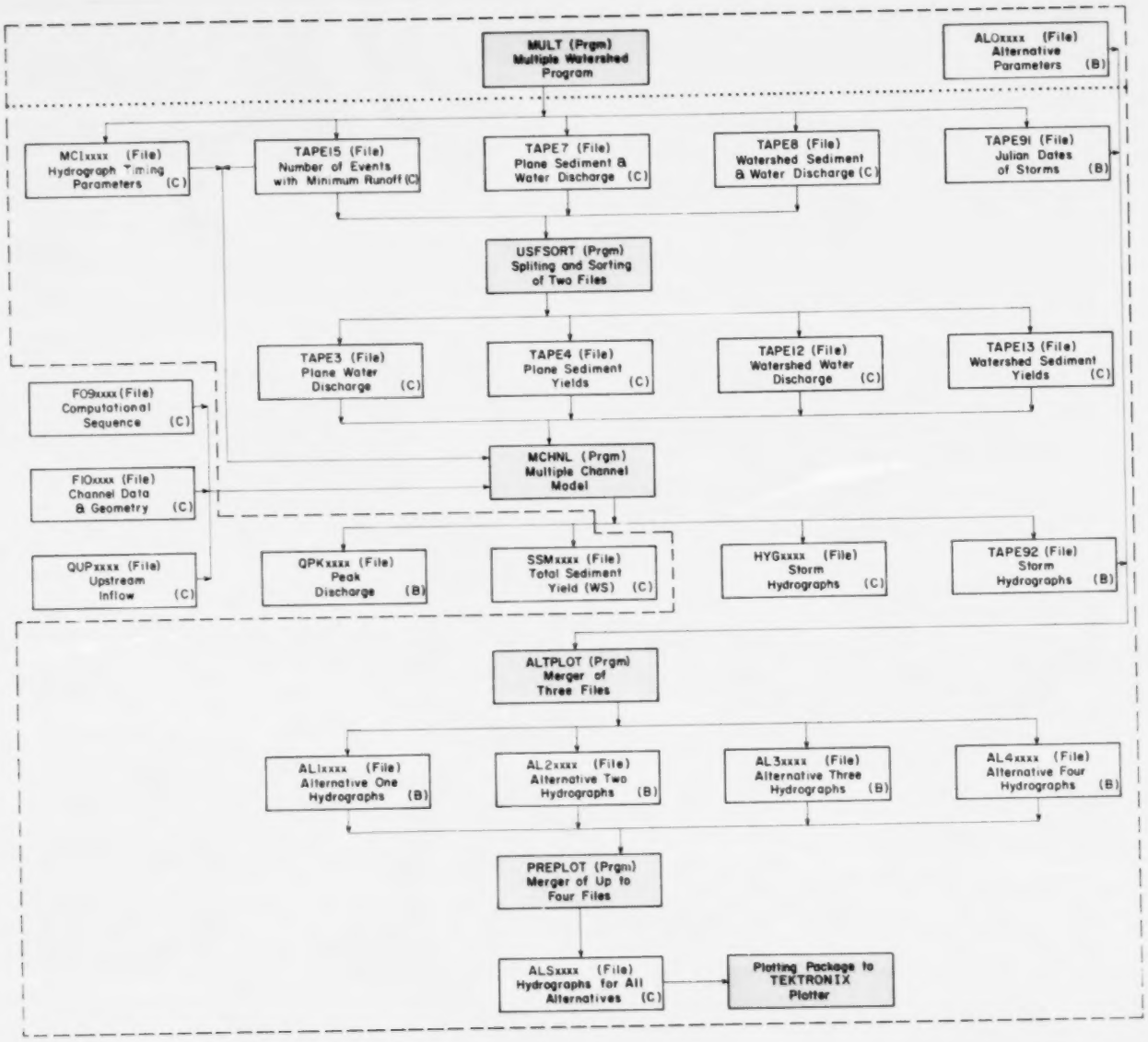


Figure B.3. Water and Sediment Routing.

TABLE B-2. HYDROLOGIC PROCESSES CONTAINED IN SUBPROGRAMS OF GENERALIZED PLANNING MODEL HYDROLOGIC SIMULATION

HYDROL	MULT	MCHNL	OXTEMP	NUTRINT	SBEROS	RILL
Precipitation	Overland flow	Channel flow	Dissolved oxygen routing	Nitrogen ion reactions	Streambank erosion	Litter loading
Interception	Sediment detachment	Sediment transport				Rill formation
Infiltration		Sediment detachment	Thermal routing	Nitrogen loading		
Percolation		Channel aggradation and degradation	Thermal loading			
Soil drainage				Phosphorus ion reactions		
Snowmelt runoff						
Evaporation						
Evapotranspiration				Phosphorus loading		
Energy balance						
Water balance						
Canopy growth						

5. SOIxxxx - soil data, moisture tension, permeability data, field capacity, porosity for all horizons.

6. INIxxxx - soil data, nutrient concentration, peak discharge, channel data, and litter production.

7. MANxxxx - canopy cover data, ground cover data, nutrient changes due to management, and litter production rate.

8. SNOxxxx - snowmelt radiation and evaporation functions, and latitude.

INIxxxx, EDAxxxx and VOIxxxx consist of yearly input data, and along with the sequencing indices in MLIxxxx and the planar data in SOIxxxx, PARxxxx, and SNOxxxx contain no data subject to management manipulation. MANxxx contains watershed and soil data which may be affected by management. Therefore, MANxxxx serves as entry points for the LEVEL-2 GOAL output. The file INIxxxx also contains inputs for NUTRINT, SBEROS, and RILL. MANxxxx also contains inputs for NUTRINT and RILL.

HYDROL uses the information on the previous eight files to generate a variety of intermediate files which in turn help to drive the remaining subprograms. CONxxxx is a reformatted multiple watershed configuration and computational sequencing file. GEOxxxx is a reformatted watershed geometry data file. ALOxxxx contains the Julian date of the first day of simulation and the alternative number. RAOxxxx contains rainfall hyetographs. EX1xxxx contains the excess rainfall left after infiltration that is available for runoff. RUNxxxx contains values of total runoff, and solar radiation intensity and period, and air and rainfall temperatures. UMIxxxx contains data which instructs MULT to route all the storm events on its input files. TUMxxxx contains runoff timing parameters. GEOxxxx and CONxxxx are used directly as inputs to the multiple watershed simulation subprogram, MULT. RAOxxxx, UMIxxxx, TUMxxxx, and EX1xxxx also help drive MULT, but these files require further discussion. RUNxxxx supplies data to the dissolved oxygen and temperature loading model OXTEMP, but also requires further discussion.

HYDROL also generates NGExxxx, VOLxxxx, TMNxxxx and MOIxxxx which help to drive the nutrient routing model NUTRINT. NGExxxx is another reformatted watershed geometry data file which serves as an input to NUTRINT. VOLxxxx and MOIxxxx contain daily runoff and infiltrated volume data and daily soil surface layer moisture content data respectively for input to NUTRINT. TMNxxxx contains the year's temperature data for NUTRINT.

The watershed simulation process breaks the watershed down into smaller single plane and two plane-one channel subunits. The simulation of water budget and fluxes by HYDROL is performed on each subunit in turn for the entire year. Since the only memory efficient manner to output data to the intermediate files is by writing data as it is calculated, this form of output results in data that consists of spatially ordered groups of temporally ordered data. For example, the EX1xxxx file consists of all excess rainfall events in chronological order for subwatershed one, followed by the chronologically ordered excess for subwatershed two, and so forth. The same is true of the hyetographs residing on RAOxxxx, and the data on the files RUNxxxx and TUMxxxx.

The multiple watershed water and sediment routing model was developed to simulate storm runoff from a group of subwatersheds on a storm by storm basis. Therefore, the data on files RAOxxxx and EX1xxxx are in the wrong order for subprogram MULT. MULT requires that the data be in the following order; storm 1 data for all subwatersheds, followed by storm 2 data for all subwatersheds, and so on through the simulation. That is, MULT requires data that consists of temporally ordered groups of spatially ordered data. The most efficient way to change the order of data at Colorado State University is to use a system level sorting program, which is the only non-portable part of the model, known as SORT/MERGE. SORT/ MERGE is used to reorder the data on

RAOxxxx and EX1xxxx to create files RAIxxxx and EXCxxxx. The data on the files RUNxxxx and TUMxxxx are reordered by SORT/MERGE, but the same file names are retained. However, after weighing speed against the non-standard aspect of SORT/MERGE, the routine was selected for use since most large computing facilities have a system sorting routine analogous to SORT/ MERGE (see list of program SORTFIL in Appendix D for this portion of the model). Therefore, the use of this non-standard program should not affect the portability of the simulation. Using this routine, EX1xxxx is used to produce EXCxxxx, and RAOxxxx to give RAIxxxx, and TUMxxxx and RUNxxxx are reordered.

The reordered information on TUMxxxx and the data on UMIxxxx are then merged by the FORTRAN subprogram FMULTIN into the file UMIxxxx. The data still retains its new temporal arrangement. At this point, the FORTRAN subprogram EXMIN, using data on files MLIxxxx, and NGExxxx, and an internally set threshold, deletes, from the files UMIxxxx, RUNxxxx, RAIxxxx, and EXCxxxx, those storm events which do not exceed the threshold. Similarly, EXMIN rewrites VOLxxxx. These forms of UMIxxxx, RAIxxxx, and EXCxxxx may be used as direct inputs to MULT, and RUNxxxx to OXTEMP, and VOLxxxx to NUTRINT.

HYDROL also creates one of the files ST1xxxx, ST2xxxx, ST3xxxx, and ST4xxxx. The file created depends on the label given the LEVEL-2 GOAL decision. These files contain the daily soil saturations for plottings. See description of file MOIxxxx.

The final files produced by HYDROL are PRSxxxx and WSMxxxx. PRSxxxx is the complete output of the water balance model. Values of soil moisture, evapotranspiration, volumes, runoff, drainage interception, and evaporation are summarized in this output on a weekly or daily basis. This output is useful when the user desires detailed information on weekly or daily values for the watershed variables mentioned above. WSMxxxx contains the total water

yield for input to the summary program GOALSUM which reformats calculated watershed responses for entry into the matrix which contains the input to the second level GOAL program.

All of the input files to the water and sediment routing subprogram, MULT are supplied by HYDROL and have been described above. MULT performs the storm by storm routing of water and sediment throughout a system of subwatersheds. This subprogram also produces several scratch files that are used by the remaining subprograms. OXCxxxx is a watershed geometry file which supplies geometric data to the oxygen and temperature routing subprogram OXTEMP. In addition, OXHxxxx contains overland flow storm water runoff hydrographs for OXTEMP. As input to the nutrient routing model, MULT writes the sediment yields for each overland flow plane to SDMxxxx. These data are written to SDMxxxx in the temporal order consistent with MULT. However, the nutrient model operates on each plane for the whole year in the same way as HYDROL. Therefore, SORT/MERGE is again used to rearrange the data on SDMxxxx into spatial order. The spatially ordered sediment yields are then written to SEDxxxx which inputs to NUTRINT. MCIxxxx contains the timing parameters for the storm events, and TAPE91 contains the JULIAN dates of the storm events. TAPE15 contains the number of events being simulated. TA7xxxx contains the sediment and water discharges on the single planes, and TA8xxxx contains the same information for the watershed (2 plane) units.

The FORTRAN subprogram USFSORT takes the data on TAPE15, TA7xxxx and TA8xxxx and splits the data on TA7xxxx and TA8xxxx. TAPE3 contains the single plane water discharges and TAPE4 contains the single plane sediment yields. TAPE12 contains the water discharges for the watershed units and TAPE13 contains the sediment yields for the watersheds.

The channel routing portion of the water and sediment routing unit is the subprogram MCHNL. MCHNL has as input files, which are user supplied: F09xxxx, F10xxxx, and QUPxxxx. They, however, are not affected by LEVEL-2 GOAL decisions. F09xxxx contains the channel computational sequence. F10xxxx contains the channel geometry. QUPxxxx contains the upstream inflow for those watersheds which are downstream.

MCHNL takes the information on these three files and on MCIxxxx, TAPE15, TAPE3, TAPE4, TAPE12, and TAPE13 and creates four files. QPKxxxx is a file of the peak discharges for each storm and each main channel subdivision. This information is used by SBEROS, the streambank erosion subprogram. SSMxxxx contains the total annual sediment yield and serves as an input to GOALSUM. HYGxxxx and TAPE92 contain essentially the same data, the storm event runoff hydrographs. HYGxxxx is a coded file for immediate inspection by the user, whereas TAPE92 is a binary file saved for comparison purposes with other LEVEL-2 GOAL decisions.

Each LEVEL-2 GOAL decision results in a management alternative which reflects in the input parameters, which in turn reflects in the discharge results. The subprogram ALTPLOT takes this result in the form of TAPE91, TAPE92, and AL0xxxx and merges these files into one file. This file may be either AL1xxxx, AL2xxxx, AL3xxxx, or AL4xxxx, depending on the label given the LEVEL-2 GOAL decision. Thus, these four files contain the runoff hydrographs for the storm events for a management alternative.

Scratch file inputs to OXTEMP have already been discussed. These include RUNxxxx, CONxxxx, OXCxxxx, and OXHxxxx. The final input file to OXTEMP is OYTxxxx which contains input data intrinsic only to OXTEMP. Some data on this file are subject to manipulation by the user in order to update model inputs to reflect second-level GOAL program decisions. Similarly, the scratch file

inputs to NUTRINT are MANxxxx, INIxxxx, MOIxxxx, SEDxxxx, CONxxxx, VOLxxxx, NGExxxx, and TMNxxxx, discussed previously, as well as the intrinsic nutrient data file NUIxxxx. Again, NUIxxxx contains data updated by the user in order to reflect second-level GOAL program decisions. Finally OXTEMP produces total annual dissolved oxygen and thermal loading file OXTxxxx, and NUTRINT creates the total annual nutrient production file NUTxxxx, both of which also serve as inputs to GOALSUM.

The last two physical process subprograms are SBEROS, the streambank erosion model and RILL, the litter loading subprogram. RILL uses EX1xxx, NGExxxx, MANxxxx, INIxxxx, and intrinsic data file INLxxxx as inputs. The total litter loading is written as LITxxxx which is as an input file to GOALSUM. Inputs to SBEROS are QPKxxxx, INIxxxx, and the intrinsic streambank erosion data file BNKxxxx. SBEROS produces the total streambank sediment yield file SBExxxx, the last program created input file to GOALSUM. The only user created input file to GOALSUM is the file GOAxxxx. The inputs on this file are a summary of its inputs. GOAxxxx is initialized to zero by the user.

After all the management alternative of interest have been simulated, the subprogram PREPLOT merges the four files AL1xxxx, AL2xxxx, AL3xxxx, and AL4xxxx into the file ALSxxxx. Thus, ALSxxxx contains the runoff hydrographs for all storm events, above the threshold level set in the subprogram EXMIN, for the management alternatives of interest. Note that the threshold level in EXMIN must be held constant for all of the alternatives to be compared.

The computational sequence for one iteration of the entire hydrologic simulation begins with HYDROL. The computational sequence must follow the order in which the subprograms are listed in Table B-1 through ALTPLOT. After ALTPLOT the remaining four physical process subprograms may be run in any order. After all physical process subprograms are finished, GOALSUM is run to

interface with the second level GOAL program. GOALSUM creates the output file GOAxxxx from which the entries for the interfacing matrix are taken. The output file TAPE53 is then copied by the system to the INIxxxx file. This is repeated until all the simulation years are over. Then if GOAL constraints are not satisfied, then the output of the second-level GOAL program is read by the user, and MANxxxx is updated accordingly. After all iterations or alternatives of interest have been simulated through ALTPLOT, PREPLOT is then executed.

Inspection of the flow chart in Figures B.1, B.2, and B.3 shows that some redundancy exists in the information on the scratch files. This results from taking advantage of the greater ease of writing information to a scratch file in the appropriate format rather than modifying the receiving program to read from an already existing file. Such modifications often result in less execution time or storage being used by the subprogram. Although complex in appearance, the structure illustrated by Figure B-1 allows the substitution of scratch files for central processor memory and has been proven through use to be a workable system. If a larger, faster machine than the CYBER 172 at Colorado State University is available, the scratch file system might be discarded completely or in part in favor of central processor storage. The recombination of all or any of the subprograms into one large program could be easily accomplished by setting aside the appropriate amount of memory (by using common statements) and discarding the scratch file input-output routines (by deleting the appropriate READ and WRITE statements). A disadvantage of reserving central memory, however, is that a fixed amount of core must be set aside for each run, while scratch file space is used only as needed. Another advantage in the present structure is that it may not be necessary to run all model components for each iteration of the simulation. For example, if only

intrinsic data to streambank erosion are changed by the user, considerable time savings are realized by running SBEROS only.

Finally, many of the scratch file names contain four x's as the last characters. The user may designate a four letter watershed identifier which takes the place of the x's. This naming process allows all of the scratch files associated with a given watershed to be identified.

APPENDIX C

ANNOTATED SUBMIT FILES IN CDC JOB CONTROL LANGUAGE

This section contains the listings of the submit files described in Appendix A. A slash (/) at the beginning of a line indicates that the line is a reformatting directive and would not be included as a command in a card deck. An asterisk (*) at the beginning of a line indicates that the line is a command statement which describes the effect of the described system command. In these annotated examples, the file names ENDXXXX, PARXXXX, VOLXXXX, and SOIXXXX may be replaced by neumonics such as ENDATA, PARAMM, VOLIN, SOILIN to associate files with individual runs.

For each management alternative, the submit file RUN1181 must be run. This sill run the entire management alternative mode. The submit file RUP1181 is to run any time after the submit file RUN1181 has been run for all management alternatives (up to a maximum of four alternatives) which the user desires to compare.

```
 GET,RUN1181
/LNH,F=RUN1181
/JOB
HYDR,T2000,PR500.EGGERT
USER,EQRXFKE,TREGGE.
*
*****************************************************
*A JOB SUBMITTED FROM A TERMINAL IS CALLED A SUBMIT FILE.
*THE SYMBOL / WILL APPEAR BEFORE ALL REFORMATING DIRECTIVES.
*THE SYMBOL * WILL APPEAR BEFORE ALL COMMENT STATEMENTS.
*THE FIRST THREE LINES (ON THIS SYSTEM) MUST BE:
*1.  /JOB.  2.  XXXX,T  ,PR    ,FGHIJK  3.  USER,  ,  .
*
*FOR THIS SUBMIT FILE, LINE TWO STATES :
*THE JOB HYDR HAS A TIME LIMIT OF 2000 SECONDS AND A PAGE LIMIT
*ON ITS OUTPUT OF 500 PAGES.
*FOR THIS SUBMIT FILE, LINE THREE STATES :
*INSTRUCT THE SYSTEM TO OBTAIN THE FILES FROM THE CATALOG EQRXFKE, WITH
*PASSWORD TREGGE.
*
*THE REST OF THE INSTRUCTIONS ARE DESCRIBED BY THE COMMENTS ABOVE THEM.
*****************************************************
*
*
*INFORM THE OPERATING SYSTEM TO RUN THE JOB UNDER A LOW PROIRITY CHARGE.
*
RATE,BKG.
*
*
*RELEASE FILE OUTPUT TO OUTPUT QUEUE OR APPROPRIATE LINE PRINTER.
*
ROUTE,OUTPUT,DC=PR,UN=AD,REP=0,DEF.
*
*
*CONTENT OF REGISTER R2 IS TO BE EQUAL TO THE NUMBER OF
*YEARS BEING SIMULATED,I.E.,SET(R2=6) IF THERE ARE SIX
*YEARS TO BE SIMULATED.
*
SET(R2=NUMBER OF YEARS)
*
*
*CONTENT OF REGISTER R3 IS INITIALIZED.
*
SET(R3=0)
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE EDAXXXX, AS INPUT
*FILE TAPE 31.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE VOIXXXX, AS INPUT
*FILE TAPE 33.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE GOAXXXX, AS INPUT
*FILE TAPE 42.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MANXXXX, AS INPUT
*FILE TAPE 51.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE INIXXXX, AS INPUT
*FILE TAPE 52.
*
GET,TAPE31=EDAXXXX.
GET,TAPE33=VOIXXXX.
GET,TAPE42=GOAXXXX.
GET,TAPE51=MANXXXX.
GET,TAPE52=INIXXXX.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE OUPXXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE20=OUPXXXX/NA.
*
*
```

```
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE ST1XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE ST2XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE ST3XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE ST4XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE PRSXXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE HYGXXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE AL1XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE AL2XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE AL3XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE AL4XXXX, AND
*WRITE ON THE FILES(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILES ARE AVAILABLE (NA).
*
ATTACH,TAPE54=ST1XXXX/M=W,NA.
ATTACH,TAPE55=ST2XXXX/M=W,NA.
ATTACH,TAPE56=ST3XXXX/M=W,NA.
ATTACH,TAPE57=ST4XXXX/M=W,NA.
ATTACH,TAPE61=PRSXXXX/M=W,NA.
ATTACH,TAPE62=HYGXXXX/M=W,NA.
ATTACH,TAPE81=AL1XXXX/M=W,NA.
ATTACH,TAPE82=AL2XXXX/M=W,NA.
ATTACH,TAPE83=AL3XXXX/M=W,NA.
ATTACH,TAPE84=AL4XXXX/M=W,NA.
*
*******************************************************
*BASIM MODEL.
*******************************************************
*
*
*CONTENT OF REGISTER R1 IS EQUAL TO 1.
*1START IS A CONTROL TRANSFER LABEL.
*
1START,SET(R1=1)
*
*
*REMOVE THE PERMANENT FILE RAOXXXX FROM THE SYSTEM.
*
PURGE,RAOXXXX.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 1AB1.
*
GOTO,1AB1.
*
*
*THIS EXIT STATEMENT INSURES THAT IN THE EVENT OF AN ERROR IN
*THE PREVIOUS PURGE COMMAND, THE JOB IS NOT ABORTED AND THE NEXT
*COMMAND IS ATTEMPTED.
*
EXIT.
*
*
*WHEN R1 DOES NOT EQUAL 1, TRANSFER CONTROL TO COMMAND LABELED 2WX2.
*THIS HAPPENS WHENEVER THERE IS AN ERROR WHICH IS NOT RELATED TO ANY
*PREVIOUS PURGE COMMAND.  OTHERWISE, PROCEED TO SUBSEQUENT COMMAND.
*
IF(R1.NE.1) GOTO,2WX2.
*
*
*REMOVE THE PERMANENT FILE EXCXXXX FROM THE SYSTEM.
*1AB1 IS A CONTROL TRANSFER LABEL.
*
1AB1,PURGE,EXCXXXX.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 2AB2.
*
GOTO,2AB2.
*
*
```

```
*THIS EXIT STATEMENT INSURES THAT IN THE EVENT OF AN ERROR IN
*THE PREVIOUS PURGE COMMAND, THE JOB IS NOT ABORTED AND THE NEXT
*COMMAND IS ATTEMPTED.
*
EXIT.
*
*
*REMOVE THE PERMANENT FILE EX1XXXX FROM THE SYSTEM.
*2AB2 IS A CONTROL TRANSFER LABEL.
*
2AB2,PURGE,EX1XXXX.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 3AB3.
*
GOTO,3AB3.
*
*
*THIS EXIT STATEMENT INSURES THAT IN THE EVENT OF AN ERROR IN
*THE PREVIOUS PURGE COMMAND, THE JOB IS NOT ABORTED AND THE NEXT
*COMMAND IS ATTEMPTED.
*
EXIT.
*
*
*REMOVE THE PERMANENT FILE RAIXXXX FROM THE SYSTEM.
*3AB3 IS A CONTROL TRANSFER LABEL.
*
3AB3,PURGE,RAIXXXX.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 4AB4.
*
GOTO,4AB4.
*
*
*THIS EXIT STATEMENT INSURES THAT IN THE EVENT OF AN ERROR IN
*THE PREVIOUS PURGE COMMAND, THE JOB IS NOT ABORTED AND THE NEXT
*COMMAND IS ATTEMPTED.
*
EXIT.
*
*
*CREATE THE DIRECT ACCESS PERMANENT FILE EXCXXXX AND ATTACH IT TO THE JOB.
*CREATE THE DIRECT ACCESS PERMANENT FILE EX1XXXX AND ATTACH IT TO THE JOB.
*CREATE THE DIRECT ACCESS PERMANENT FILE RAIXXXX AND ATTACH IT TO THE JOB.
*CREATE THE DIRECT ACCESS PERMANENT FILE RAOXXXX AND ATTACH IT TO THE JOB.
*ESTABLISH THE FILES AS SEMI-PRIVATE (CT=S) AND RESERVE ENOUGH SPACE FOR
*THE FILES (S=10000).  4AB4 IS A CONTROL TRANSFER LABEL.
*
4AB4,DEFINE,EXCXXXX,EX1XXXX,RAIXXXX,RAOXXXX/CT=S,S=10000.
*
*
*RELEASE THE PERMANENT FILE EXCXXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE EX1XXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE RAIXXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE RAOXXXX FROM THE JOB.
*
RETURN,EXCXXXX,EX1XXXX,RAIXXXX,RAOXXXX.
*
*
*CONTENT OF REGISTER R3 IS INCREMENTED.
*
SET(R3=R3+1)
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EX1XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE RAOXXXX, AND
*WRITE ON THE FILES(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILES ARE AVAILABLE (WA).
```

```
*
ATTACH,TAPE8=EX1XXXX/M=W,NA.
ATTACH,TAPE14=RAOXXXX/M=W,NA.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE PARXXXX, AS INPUT
*FILE TAPE2.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MLIXXXX, AS INPUT
*FILE TAPE4.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SOIXXXX, AS INPUT
*FILE TAPE7.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SNOXXXX, AS INPUT
*FILE TAPE 85.
*
GET,TAPE2=PARXXXX.
GET,TAPE4=MLIXXXX.
GET,TAPE7=SOIXXXX.
GET,TAPE85=SNOXXXX.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE HYDROL, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,HYDROL/NA.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE HYDROL,
*THE COMPILED PROGRAM IS TO BE BHYDROL, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=HYDROL,B=BHYDROL.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BHYDROL IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
BHYDROL.
*
*
*POSITION THE FILE TAPE10 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE11 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE12 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE13 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE15 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE16 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE17 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE18 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE21 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE22 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE90 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE10,TAPE11,TAPE12,TAPE13,TAPE15,TAPE16,TAPE17.
REWIND,TAPE18,TAPE21,TAPE22,TAPE90.
*
*
*PLACE THE FILE WSMXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE RUNXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE GEOXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE CONXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE VOLXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE NGEXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE MOIXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE TMNXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE TUMXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE UMIXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
```

```
*PLACE THE FILE AL0XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE10=WSMXXXX,TAPE11=RUNXXXX,TAPE12=GEOXXXX,TAPE13=CONXXXX.
REPLACE,TAPE15=VOLXXXX,TAPE16=NGEXXXX,TAPE17=MOIXXXX,TAPE18=TMNXXXX.
REPLACE,TAPE21=TUMXXXX,TAPE22=UMIXXXX,TAPE90=AL0XXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SORTFIL.
*
GET,SORTFIL.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
*RELEASE THE FILE TAPE8 FROM THE JOB.
*
RETURN,TAPE1,TAPE2.
RETURN,TAPE8.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EX1XXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE1=EX1XXXX/NA.
*
*
*POSITION THE FILE TAPE1 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE1,TAPE2.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE1 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE1,BT=I,RT=W,MRL=1100.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE2 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE2,BT=I,RT=W,MRL=1100.
*
*
*CALL THE SYSTEM ROUTINE SORT/MERGE TO PROCESS DIRECTIVES CONTAINED
*ON FILE SORTFIL.
*
SORTMRG,I=SORTFIL.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EXCXXXX, AND
*WRITE ON THE FILE(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,EXCXXXX/M=W,NA.
*
*
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE2.
*
*
*COPY FILE TAPE2 ONTO FILE EXCXXXX STARTING AT CURRENT POSITION OF BOTH
*FILES.
*
COPY,TAPE2,EXCXXXX.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
```

```
*RELEASE THE FILE TAPE14 FROM THE JOB.
*
RETURN,TAPE1,TAPE2.
RETURN,TAPE14.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE RAOXXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE1=RAOXXXX/NA.
*
*
*POSITION THE FILE SORTFIL AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE1 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,SORTFIL.
REWIND,TAPE1,TAPE2.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE1 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE1,BT=I,RT=W,MRL=1100.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE2 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE2,BT=I,RT=W,MRL=1100.
*
*
*CALL THE SYSTEM ROUTINE SORT/MERGE TO PROCESS DIRECTIVES CONTAINED
*ON FILE SORTFIL.
*
*
SORTMRG,I=SORTFIL.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE RAIXXXX, AND
*WRITE ON THE FILE(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,RAIXXXX/M=W,NA.
*
*
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE2.
*
*
*COPY FILE TAPE2 ONTO FILE RAIXXXX STARTING AT CURRENT POSITION OF BOTH
*FILES.
*
COPY,TAPE2,RAIXXXX.
*
*
*REMOVE THE PERMANENT FILE RAOXXXX FROM THE SYSTEM.
*
PURGE,RAOXXXX.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
*
RETURN,TAPE1,TAPE2.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE TUMXXXX, AS INPUT
*FILE TAPE1.
```

```
*
GET,TAPE1=TUMXXXX.
*
*
*POSITION THE FILE SORTFIL AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE1 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,SORTFIL.
REWIND,TAPE1,TAPE2.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE1 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE1,BT=I,RT=W,MRL=1100.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE2 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE2,BT=I,RT=W,MRL=1100.
*
*
*CALL THE SYSTEM ROUTINE SORT/MERGE TO PROCESS DIRECTIVES CONTAINED
*ON FILE SORTFIL.
*
SORTMRG,I=SORTFIL.
*
*
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE2.
*
*
*PLACE THE FILE TUMXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE2=TUMXXXX.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
*
RETURN,TAPE1,TAPE2.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE RUNXXXX, AS INPUT
*FILE TAPE1.
*
GET,TAPE1=RUNXXXX.
*
*
*POSITION THE FILE SORTFIL AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE1 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,SORTFIL.
REWIND,TAPE1,TAPE2.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE1 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE1,BT=I,RT=W,MRL=1100.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE2 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE2,BT=I,RT=W,MRL=1100.
```

```
*
*
*CALL THE SYSTEM ROUTINE SORT/MERGE TO PROCESS DIRECTIVES CONTAINED
*ON FILE SORTFIL.
*
SORTMRG,I=SORTFIL.
*
*
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE2.
*
*
*PLACE THE FILE RUNXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE2=RUNXXXX.
*
*
*RELEASE THE FILE TAPE2 FROM THE JOB.
*
RETURN,TAPE2.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE TUMXXXX, AS INPUT
*FILE TAPE66.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE UMIXXXX, AS INPUT
*FILE TAPE65.
*
GET,TAPE66=TUMXXXX.
GET,TAPE65=UMIXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE FMULTIN.
*
GET,FMULTIN.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE FMULTIN,
*THE COMPILED PROGRAM IS TO BE BMULTIN, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=FMULTIN,B=BMULTIN.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BMULTIN IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
BMULTIN.
*
*
*POSITION THE FILE TAPE65 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE65.
*
*
*PLACE THE FILE UMIXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE65=UMIXXXX.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE3 FROM THE JOB.
*RELEASE THE FILE TAPE4 FROM THE JOB.
*RELEASE THE FILE TAPE5 FROM THE JOB.
*RELEASE THE FILE TAPE6 FROM THE JOB.
```

```
*RELEASE THE FILE TAPE7 FROM THE JOB.
*RELEASE THE FILE TAPE9 FROM THE JOB.
*RELEASE THE FILE TAPE10 FROM THE JOB.
*RELEASE THE FILE TAPE11 FROM THE JOB.
*RELEASE THE FILE TAPE12 FROM THE JOB.
*RELEASE THE FILE TAPE13 FROM THE JOB.
*RELEASE THE FILE TAPE15 FROM THE JOB.
*RELEASE THE FILE TAPE16 FROM THE JOB.
*RELEASE THE FILE TAPE17 FROM THE JOB.
*RELEASE THE FILE TAPE18 FROM THE JOB.
*RELEASE THE FILE TAPE21 FROM THE JOB.
*RELEASE THE FILE TAPE22 FROM THE JOB.
*RELEASE THE FILE TAPE65 FROM THE JOB.
*RELEASE THE FILE TAPE66 FROM THE JOB.
*RELEASE THE FILE TAPE90 FROM THE JOB.
*
RETURN,TAPE1,TAPE3,TAPE4,TAPE5,TAPE6,TAPE7,TAPE9,TAPE10.
RETURN,TAPE11,TAPE12,TAPE13,TAPE15,TAPE16,TAPE17,TAPE18.
RETURN,TAPE21,TAPE22,TAPE65,TAPE66,TAPE90.
*
*
*RELEASE THE PERMANENT FILE EXCXXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE RAIXXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE SORTFIL FROM THE JOB.
*
RETURN,EXCXXXX,RAIXXXX,SORTFIL.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EXCXXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE RAIXXXX, AND
*WAIT UNTIL THE FILES ARE AVAILABLE (NA).
*
ATTACH,TAPE1=EXCXXXX,TAPE3=RAIXXXX/NA.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE RUNXXXX, AS INPUT
*FILE TAPE5.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE UMIXXXX, AS INPUT
*FILE TAPE7.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MLIXXXX, AS INPUT
*FILE TAPE9.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE NGEXXXX, AS INPUT
*FILE TAPE10.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE VOLXXXX, AS INPUT
*FILE TAPE13.
*
GET,TAPE5=RUNXXXX,TAPE7=UMIXXXX.
GET,TAPE9=MLIXXXX,TAPE10=NGEXXXX.
GET,TAPE13=VOLXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE EXMIN.
*
GET,EXMIN.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE EXMIN,
*THE COMPILED PROGRAM IS TO BE BEMIN, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=EXMIN,B=BEMIN.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BEMIN IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
```

```
*
BEMIN.
*
*
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE4 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE6 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE8 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE14 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE2,TAPE4,TAPE6,TAPE8,TAPE14.
*
*
*PLACE THE FILE RUNXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE UMIXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE VOLXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE6=RUNXXXX.
REPLACE,TAPE8=UMIXXXX.
REPLACE,TAPE14=VOLXXXX.
*
*
*RELEASE THE FILE TAPE5 FROM THE JOB.
*RELEASE THE FILE TAPE6 FROM THE JOB.
*RELEASE THE FILE TAPE7 FROM THE JOB.
*RELEASE THE FILE TAPE8 FROM THE JOB.
*RELEASE THE FILE TAPE9 FROM THE JOB.
*RELEASE THE FILE TAPE10 FROM THE JOB.
*RELEASE THE FILE TAPE11 FROM THE JOB.
*RELEASE THE FILE TAPE12 FROM THE JOB.
*RELEASE THE FILE TAPE13 FROM THE JOB.
*RELEASE THE FILE TAPE14 FROM THE JOB.
*
RETURN,TAPE5,TAPE6,TAPE7,TAPE8,TAPE9,TAPE10.
RETURN,TAPE11,TAPE12,TAPE13,TAPE14.
*
*
*RELEASE THE PERMANENT FILE EXCXXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE RAIXXXX FROM THE JOB.
*
RETURN,TAPE1,TAPE3.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EXCXXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE RAIXXXX, AND
*WRITE ON THE FILES(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILES ARE AVAILABLE (NA).
*
ATTACH,EXCXXXX,RAIXXXX/M=W,NA.
*
*
*COPY FILE TAPE2 ONTO FILE EXCXXXX STARTING AT CURRENT POSITION OF BOTH
*FILES.
*
COPY,TAPE2,EXCXXXX.
*
*
*COPY FILE TAPE4 ONTO FILE RAIXXXX STARTING AT CURRENT POSITION OF BOTH
*FILES.
*
COPY,TAPE4,RAIXXXX.
*
*
*RELEASE THE FILE TAPE2 FROM THE JOB.
*RELEASE THE FILE TAPE4 FROM THE JOB.
*
RETURN,TAPE2,TAPE4.
*
*
*RELEASE THE PERMANENT FILE EXCXXXX FROM THE JOB.
```

```
*RELEASE THE PERMANENT FILE RAIXXXX FROM THE JOB.
*
RETURN,EXCXXXX,RAIXXXX.
*
*****************************************************
*MULTIPLE WATERSHED RUNOFF MODEL.
*****************************************************
*
*
*CONTENT OF REGISTER R1 IS EQUAL TO 7.
*
SET(R1=7)
*
*
*REMOVE THE PERMANENT FILE SDMXXXX FROM THE SYSTEM.
*
PURGE,SDMXXXX.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 7WX7.
*
GOTO,7WX7.
*
*
*THIS EXIT STATEMENT INSURES THAT IN THE EVENT OF AN ERROR IN
*THE PREVIOUS PURGE COMMAND, THE JOB IS NOT ABORTED AND THE NEXT
*COMMAND IS ATTEMPTED.
*
EXIT.
*
*
*WHEN R1 DOES NOT EQUAL 7, TRANSFER CONTROL TO COMMAND LABELED 2WX2.
*THIS HAPPENS WHENEVER THERE IS AN ERROR WHICH IS NOT RELATED TO ANY
*PREVIOUS PURGE COMMAND.  OTHERWISE, PROCEED TO SUBSEQUENT COMMAND.
*
IF(R1.NE.7) GOTO,2WX2.
*
*
*REMOVE THE PERMANENT FILE SEDXXXX FROM THE SYSTEM.
*7WX7 IS A CONTROL TRANSFER LABEL.
*
7WX7,PURGE,SEDXXXX.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 1BC1.
*
GOTO,1BC1.
*
*
*THIS EXIT STATEMENT INSURES THAT IN THE EVENT OF AN ERROR IN
*THE PREVIOUS PURGE COMMAND, THE JOB IS NOT ABORTED AND THE NEXT
*COMMAND IS ATTEMPTED.
*
EXIT.
*
*
*CREATE THE DIRECT ACCESS PERMANENT FILE SEDXXXX AND ATTACH IT TO THE JOB.
*CREATE THE DIRECT ACCESS PERMANENT FILE SDMXXXX AND ATTACH IT TO THE JOB.
*ESTABLISH THE FILES AS SEMI-PRIVATE (CT=S) AND RESERVE ENOUGH SPACE FOR
*THE FILES (S=10000).  1BC1 IS A CONTROL TRANSFER LABEL.
*
1BC1,DEFINE,SEDXXXX,SDMXXXX/CT=S,S=10000.
*
*
*RELEASE THE PERMANENT FILE SEDXXXX FROM THE JOB.
*RELEASE THE PERMANENT FILE SDMXXXX FROM THE JOB.
*
RETURN,SEDXXXX,SDMXXXX.
*
*
```

```
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE TA7XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE TA8XXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE OXHXXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE SDMXXXX, AND
*WRITE ON THE FILES(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILES ARE AVAILABLE (NA).
*
ATTACH,TAPE7=TA7XXXX/M=W,NA.
ATTACH,TAPE8=TA8XXXX/M=W,NA.
ATTACH,TAPE18=OXHXXXX/M=W,NA.
ATTACH,TAPE19=SDMXXXX/M=W,NA.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE RAIXXXX, AND
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EXCXXXX, AND
*WAIT UNTIL THE FILES ARE AVAILABLE (NA).
*
ATTACH,TAPE2=RAIXXXX/NA.
ATTACH,TAPE16=EXCXXXX/NA.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE1 FOR USE BY
*PROGRAM MULT.
*
FILE,TAPE1.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE GEOXXXX, AS INPUT
*FILE TAPE1.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE CONXXXX, AS INPUT
*FILE TAPE3.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE UMIXXXX.
*
GET,TAPE1=GEOXXXX.
GET,TAPE3=CONXXXX.
GET,UMIXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MULT.
*
GET,MULT.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE MULT,
*THE COMPILED PROGRAM IS TO BE MULTB, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=MULT,B=MULTB.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*MULTB IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*UMIXXXX CONTAINS THE DATA TO BE READ FROM FILE INPUT.
*
MULTB,UMIXXXX.
*
*
*POSITION THE FILE TAPE15 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE17 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE75 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE91 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE15,TAPE17,TAPE75,TAPE91.
*
*
```

```
*PLACE THE FILE T15XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE OXCXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE MCIXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE T91XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE15=T15XXXX,TAPE17=OXCXXXX,TAPE75=MCIXXXX,TAPE91=T91XXXX.
*
*
*RELEASE THE PERMANENT FILE CONXXXX FROM THE JOB.
*
RETURN,TAPE3.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE USFSORT.
*
GET,USFSORT.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE USFSORT,
*THE COMPILED PROGRAM IS TO BE USBSORT, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=USFSORT,B=USBSORT.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*USBSORT IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
USBSORT.
*
*
*POSITION THE FILE TAPE3 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE4 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE12 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE13 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE15 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE3,TAPE4,TAPE12,TAPE13,TAPE15.
*
*
*PLACE THE FILE T03XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE T04XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE T12XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE T13XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE3=T03XXXX,TAPE4=T04XXXX,TAPE12=T12XXXX,TAPE13=T13XXXX.
*
*
*RELEASE THE FILE TAPE19 FROM THE JOB.
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
*
RETURN,TAPE19.
RETURN,TAPE1,TAPE2.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE SDMXXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE1=SDMXXXX/NA.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SORTFIL.
*
GET,SORTFIL.
```

```
*
*
*POSITION THE FILE TAPE1 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE1,TAPE2.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE1 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE1,BT=I,RT=W,MRL=1100.
*
*
*UPDATE FILE INFORMATION TABLE OF FILE TAPE2 FOR USE BY
*SYSTEM ROUTINE SORT/MERGE.
*
FILE,TAPE2,BT=I,RT=W,MRL=1100.
*
*
*CALL THE SYSTEM ROUTINE SORT/MERGE TO PROCESS DIRECTIVES CONTAINED
*ON FILE SORTFIL.
*
SORTMRG,I=SORTFIL.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE SEDXXXX, AND
*WRITE ON THE FILE(M=W) AT THE BEGINNING OF INFORMATION (BOI), AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,SEDXXXX/M=W,NA.
*
*
*POSITION THE FILE TAPE2 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE2.
*
*
*COPY FILE TAPE2 ONTO FILE SEDXXXX STARTING AT CURRENT POSITION OF BOTH
*FILES.
*
COPY,TAPE2,SEDXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE F09XXXX, AS INPUT
*FILE TAPE9.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE F10XXXX, AS INPUT
*FILE TAPE10.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MCIXXXX.
*
GET,TAPE9=F09XXXX.
GET,TAPE10=F10XXXX.
GET,MCIXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MCHNL.
*
GET,MCHNL.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE MCHNL,
*THE COMPILED PROGRAM IS TO BE BMCHNL, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=MCHNL,B=BMCHNL.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
```

```
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BMCHNL IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*MCIXXXX CONTAINS THE DATA TO BE READ FROM FILE INPUT.
*
BMCHNL,MCIXXXX.
*
*
*POSITION THE FILE TAPE48 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE50 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE92 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE48,TAPE50,TAPE92.
*
*
*PLACE THE FILE SSMXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE QPKXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*PLACE THE FILE T92XXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE48=SSMXXXX.
REPLACE,TAPE50=QPKXXXX.
REPLACE,TAPE92=T92XXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE AL0XXXX, AS INPUT
*FILE TAPE90.
*
GET,TAPE90=AL0XXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE ALTPLOT.
*
GET,ALTPLOT.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE ALTPLOT,
*THE COMPILED PROGRAM IS TO BE BPLOT, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=ALTPLOT,B=BPLOT.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BPLOT IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
BPLOT.
*
*
*REMOVE THE PERMANENT FILE SDMXXXX FROM THE SYSTEM.
*
PURGE,SDMXXXX.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
*RELEASE THE FILE TAPE3 FROM THE JOB.
*RELEASE THE FILE TAPE4 FROM THE JOB.
*RELEASE THE FILE TAPE5 FROM THE JOB.
*RELEASE THE FILE TAPE6 FROM THE JOB.
*RELEASE THE FILE TAPE7 FROM THE JOB.
*RELEASE THE FILE TAPE8 FROM THE JOB.
*RELEASE THE FILE TAPE9 FROM THE JOB.
*RELEASE THE FILE TAPE10 FROM THE JOB.
*RELEASE THE FILE TAPE11 FROM THE JOB.
```

```
*RELEASE THE FILE TAPE12 FROM THE JOB.
*RELEASE THE FILE TAPE13 FROM THE JOB.
*RELEASE THE FILE TAPE15 FROM THE JOB.
*RELEASE THE FILE TAPE16 FROM THE JOB.
*RELEASE THE FILE TAPE17 FROM THE JOB.
*RELEASE THE FILE TAPE18 FROM THE JOB.
*RELEASE THE FILE TAPE48 FROM THE JOB.
*RELEASE THE FILE TAPE50 FROM THE JOB.
*RELEASE THE FILE TAPE75 FROM THE JOB.
*RELEASE THE FILE TAPE90 FROM THE JOB.
*RELEASE THE FILE TAPE91 FROM THE JOB.
*RELEASE THE FILE TAPE92 FROM THE JOB.
*RELEASE THE FILE TAPE93 FROM THE JOB.
*RELEASE THE FILE TAPE98 FROM THE JOB.
*RELEASE THE FILE TAPE99 FROM THE JOB.
*
RETURN,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,TAPE6,TAPE7,TAPE8,TAPE9,TAPE10.
RETURN,TAPE11,TAPE12,TAPE13,TAPE15,TAPE16,TAPE17,TAPE18.
RETURN,TAPE48,TAPE50,TAPE75.
RETURN,TAPE90,TAPE91,TAPE92,TAPE93,TAPE98,TAPE99.
*
*
*RELEASE THE PERMANENT FILE SEDXXXX FROM THE JOB.
*
RETURN,SEDXXXX.
*
*******************************************************
*NUTRIENT MODEL.
*******************************************************
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE SEDXXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE2=SEDXXXX/NA.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE VOLXXXX, AS INPUT
*FILE TAPE1.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE TMNXXXX, AS INPUT
*FILE TAPE3.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE MOIXXXX, AS INPUT
*FILE TAPE4.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE CONXXXX, AS INPUT
*FILE TAPE5.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE NGEXXXX, AS INPUT
*FILE TAPE6.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE NUIXXXX.
*
GET,TAPE1=VOLXXXX.
GET,TAPE3=TMNXXXX.
GET,TAPE4=MOIXXXX.
GET,TAPE5=CONXXXX.
GET,TAPE6=NGEXXXX.
GET,NUIXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE NUTRINT.
*
GET,NUTRINT.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE NUTRINT,
*THE COMPILED PROGRAM IS TO BE BNUTRNT, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=NUTRINT,B=BNUTRNT.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
```

```
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BNUTRNT IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*NUIXXXX CONTAINS THE DATA TO BE READ FROM FILE INPUT.
*
BNUTRNT,NUIXXXX.
*
*
*POSITION THE FILE TAPE8 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE8.
*
*
*PLACE THE FILE NUTXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE8=NUTXXXX.
*
*
*RELEASE THE FILE TAPE1 FROM THE JOB.
*RELEASE THE FILE TAPE2 FROM THE JOB.
*RELEASE THE FILE TAPE3 FROM THE JOB.
*RELEASE THE FILE TAPE4 FROM THE JOB.
*RELEASE THE FILE TAPE5 FROM THE JOB.
*RELEASE THE FILE TAPE6 FROM THE JOB.
*RELEASE THE FILE TAPE8 FROM THE JOB.
*RELEASE THE FILE TAPE96 FROM THE JOB.
*RELEASE THE FILE TAPE97 FROM THE JOB.
*
RETURN,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,TAPE6,TAPE8,TAPE96,TAPE97.
*
*****************************************************
*OXYGEN TEMPERATURE MODEL.
*****************************************************
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE RUNXXXX, AS INPUT
*FILE TAPE3.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE CONXXXX, AS INPUT
*FILE TAPE5.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE OXCXXXX, AS INPUT
*FILE TAPE8.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE OYTXXXX.
*
GET,TAPE3=RUNXXXX.
GET,TAPE5=CONXXXX.
GET,TAPE8=OXCXXXX.
GET,OYTXXXX.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE OXHXXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE4=OXHXXXX/NA.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE OXTEMP.
*
GET,OXTEMP.
*
*
*CALL THE FORTRAN COMPILER. THE SOURCE PROGRAM IS ON FILE OXTEMP,
*THE COMPILED PROGRAM IS TO BE BOXTEMP, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=OXTEMP,B=BOXTEMP.
*
*
```

```
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BOXTEMP IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*OYTXXXX CONTAINS THE DATA TO BE READ FROM FILE INPUT.
*
BOXTEMP,OYTXXXX.
*
*
*POSITION THE FILE TAPE9 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE9.
*
*
*PLACE THE FILE OXTXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE9=OXTXXXX.
*
*
*RELEASE THE FILE TAPE3 FROM THE JOB.
*RELEASE THE FILE TAPE4 FROM THE JOB.
*RELEASE THE FILE TAPE5 FROM THE JOB.
*RELEASE THE FILE TAPE7 FROM THE JOB.
*RELEASE THE FILE TAPE8 FROM THE JOB.
*RELEASE THE FILE TAPE9 FROM THE JOB.
*RELEASE THE FILE TAPE95 FROM THE JOB.
*
RETURN,TAPE3,TAPE4,TAPE5,TAPE7,TAPE8,TAPE9,TAPE95.
*
*****************************************************
*SOIL BANK EROSION MODEL.
*****************************************************
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE BNKXXXX, AS INPUT
*FILE TAPE49.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE QPKXXXX, AS INPUT
*FILE TAPE50.
*
GET,TAPE49=BNKXXXX.
GET,TAPE50=QPKXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SBEROS.
*
GET,SBEROS.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE SBEROS,
*THE COMPILED PROGRAM IS TO BE BSBEROS, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=SBEROS,B=BSBEROS.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BSBEROS IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
BSBEROS.
*
*
*POSITION THE FILE TAPE48 AT THE BEGINNING OF INFORMATION.
```

```
*
REWIND,TAPE48.
*
*
*PLACE THE FILE SBEXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE48=SBEXXXX.
*
*
*RELEASE THE FILE TAPE6 FROM THE JOB.
*RELEASE THE FILE TAPE48 FROM THE JOB.
*RELEASE THE FILE TAPE49 FROM THE JOB.
*RELEASE THE FILE TAPE50 FROM THE JOB.
*
RETURN,TAPE6,TAPE48,TAPE49,TAPE50.
*
*****************************************************
*LITTER MODEL.
*****************************************************
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE INLXXXX, AS INPUT
*FILE TAPE5.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE NGEXXXX, AS INPUT
*FILE TAPE7.
*
GET,TAPE5=INLXXXX.
GET,TAPE7=NGEXXXX.
*
*
*GIVE THE JOB ACCESS TO THE DIRECT ACCESS PERMANENT FILE EX1XXXX, AND
*WAIT UNTIL THE FILE IS AVAILABLE (NA).
*
ATTACH,TAPE8=EX1XXXX/NA.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE RILL.
*
GET,RILL.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE RILL,
*THE COMPILED PROGRAM IS TO BE BRILL, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=RILL,B=BRILL.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BRILL IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
BRILL.
*
*
*POSITION THE FILE TAPE4 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE4.
*
*
*PLACE THE FILE LITXXXX IN PERMANENT STORAGE FOR FUTURE REFERENCE.
*
REPLACE,TAPE4=LITXXXX.
*
*
*RELEASE THE PERMANENT FILE TAPE4 FROM THE JOB.
```

```
*RELEASE THE PERMANENT FILE TAPE5 FROM THE JOB.
*RELEASE THE PERMANENT FILE TAPE6 FROM THE JOB.
*RELEASE THE PERMANENT FILE TAPE7 FROM THE JOB.
*RELEASE THE PERMANENT FILE TAPE8 FROM THE JOB.
*
RETURN,TAPE4,TAPE5,TAPE6,TAPE7,TAPE8.
*
*******************************************************
*GOAL SUMMARY PROGRAM.
*******************************************************
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SSMXXXX, AS INPUT
*FILE TAPE 48.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE SBEXXXX, AS INPUT
*FILE TAPE 47.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE WSMXXXX, AS INPUT
*FILE TAPE 46.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE OXTXXXX, AS INPUT
*FILE TAPE 45.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE NUTXXXX, AS INPUT
*FILE TAPE 44.
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE LITXXXX, AS INPUT
*FILE TAPE 43.
*
GET,TAPE48=SSMXXXX.
GET,TAPE47=SBEXXXX.
GET,TAPE46=WSMXXXX.
GET,TAPE45=OXTXXXX.
GET,TAPE44=NUTXXXX.
GET,TAPE43=LITXXXX.
*
*
*GIVE THE JOB ACCESS TO THE INDIRECT ACCESS PERMANENT FILE GOALSUM.
*
GET,GOALSUM.
*
*
*CALL THE FORTRAN COMPILER.  THE SOURCE PROGRAM IS ON FILE GOALSUM,
*THE COMPILED PROGRAM IS TO BE BGOAL, THERE IS NO LIST (L=0),AND
*(R=3) IS AN INDICATION ON THE TYPE OF REFERENCE MAP.
*
FTN,L=0,R=3,I=GOALSUM,B=BGOAL.
*
*
*INFORM OPERATING SYSTEM THAT THE CORE IS TO BE PRESET TO NEGATIVE
*INFINITY, AND THE OUTPUT IS TO CONTAIN A MAP OF BLOCKS AND STATISTICS.
*
LDSET,PRESET=NGINF,MAP=BS.
*
*
*BGOAL IS THE COMPILED PROGRAM. INSTRUCT THE SYSTEM TO EXCUTE IT.
*
BGOAL.
*
*
*WHEN R3 IS GREATER THAN OR EQUAL TO R2, TRANSFER CONTROL TO COMMAND
*LABELED 1END.  THIS HAPPENS WHENEVER THE NUMBER OF YEARS WHICH HAVE
*BEEN SIMULATED IS GREATER THAN OR EQUAL TO THE NUMBER OF YEARS TO BE
*SIMULATED.  OTHERWISE, PROCEED TO SUBSEQUENT COMMAND.
*
IF(R3.GE.R2) GOTO,1END.
*
*
*POSITION THE FILE TAPE52 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE53 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE52,TAPE53.
*
*
```

```
*COPY FILE TAPE53 ONTO FILE TAPE52 STARTING AT CURRENT POSITION OF BOTH
*FILES.
*
COPY,TAPE53,TAPE52.
*
*
*POSITION THE FILE TAPE52 AT THE BEGINNING OF INFORMATION.
*POSITION THE FILE TAPE53 AT THE BEGINNING OF INFORMATION.
*
REWIND,TAPE52,TAPE53.
*
*
*TRANSFER CONTROL TO COMMAND LABELED 1START.
*
GOTO,1START.
*
*
*IF THERE HAVE BEEN NO ERRORS IN JOB PROCESSING, THE JOB TERMINATES HERE.
*OTHERWISE, JOB PROCESSING STOPS WITH THE ERROR, PROCEEDS TO THIS EXIT
*STATEMENT AND EXCUTES THE DIRECTIVES FOLLOWING THIS EXIT COMMAND.
*1END IS A CONTROL TRANSFER LABEL.
*
1END,EXIT.
*
*
*POSITION FILE OUTPUT AT THE BEGINNING OF INFORMATION.
*2WX2 IS A CONTROL TRANSFER LABEL.
*
2WX2,REWIND,OUTPUT.
*
*
*RELEASE FILE OUTPUT TO OUTPUT QUEUE OR APPROPRIATE LINE PRINTER.
*
ROUTE,OUTPUT,DC=PR,UN=AD,REP=0,DEF.
*
*
*INDICATE AN END OF FILE MARK IS TO BE PLACED AT THIS POINT IN THE
*SUBMIT FILE DURING REFORMATING.
*
/EOF
 EOI ENCOUNTERED.
/
```

APPENDIX D

LISTING OF PROGRAMS

TABLE OF CONTENTS

	Page
PROGRAM HYDROL	169
PROGRAM SORTFIL	238
PROGRAM EXMIN	238
PROGRAM FMULTIN	241
PROGRAM MULT	241
PROGRAM USFSORT	270
PROGRAM MCHNL	271
PROGRAM PREPLOT	287
PROGRAM ALTPLOT	292
PROGRAM NUTRINT	294
PROGRAM OXTEMP	312
PROGRAM SBEROS	319
PROGRAM RILL	322
PROGRAM GOALSUM	325

```
      BLOCK DATA
C
C     DECLARATION OF COMMON BLOCKS IN THE PROGRAM HYDROL.
C
      COMMON /ARAYS/        RA(215)     , IA(64)
      COMMON /BLOCK/        RB(56)      , IB(23)
      COMMON /BLOK2/        RC(15)
      COMMON /BLOK3/        RD(4)       , ID(2)
      COMMON /BLOK4/        RE(8)
      COMMON /BLOK5/        RF(4)
      COMMON /DNLCR/        RG(17)      , IG(4)
      COMMON /SHINE/        RH(168)     , IH
      COMMON /VAR99/        RJ(3)
      COMMON /WTRBL/        RK(10)
      COMMON /ZBLOK/        IL
      END
       PROGRAM HYDROL
      1(INPUT,OUTPUT,TAPE2=65,TAPE4=65,TAPE6=OUTPUT,TAPE7=65,TAPE8=513,TA
      2PE10=65,TAPE11=513,TAPE12=65,TAPE13=65,TAPE14=513,TAPE15=513,TAPE1
      36=513,TAPE17=513,TAPE18=513,TAPE21=513,TAPE22=65,TAPE31=65,TAPE33=
      465,TAPE51=65,TAPE52=65,TAPE53=65,TAPE54=513,TAPE55=513,TAPE56=513,
      STAPE57=513,TAPE61=65,TAPE85=65,TAPE90=513,TAPE94=513)
C
C     ##################################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ##################################################################
C
C     INPUT FILES
C        READ (2,FM)   = PARYYY
C        READ (4,FM)   = HLIYYY
C        READ (7,FM)   = SOIYYY
C        READ (31,FM)  = EDAYYY
C        READ (33,FM)  = UDIYYY
C        READ (51,FM)  = MANYYY
C        READ (52,FM)  = T52YYY
C        READ (85,FM)  = SNOYYY
C
C     OUTPUT FILES
C        WRITE (6,FM)  = LINE PRINTER
C        WRITE (8)     = EV1YYY
C        WRITE (10,FM) = WSHYYY
C        WRITE (11)    = RUNYYY
C        WRITE (12,FM) = GEOYYY
C        WRITE (13,FM) = CONYYY
C        WRITE (14)    = RADYYY
C        WRITE (15)    = UDLYYY
C        WRITE (16)    = NGEYYY
C        WRITE (17)    = MDIYYY
C        WRITE (18)    = TMNYYY
C        WRITE (21)    = TUNYYY
C        WRITE (22,FM) = UMIYYY
C        WRITE (53,FM) = T53YYY
C        WRITE (54)    = ST1YYY
C        WRITE (55)    = ST2YYY
C        WRITE (56)    = ST3YYY
C        WRITE (57)    = ST4YYY
C        WRITE (61,FM) = PRSYYY
C        WRITE (90)    = ALOYYY
C        WRITE (94)    = DUMYYY
C
C     ##################################################################
C     HYDROL IS A SEASONAL OR YEARLY WATERSHED SIMULATION INCORPORATING
C     MOST OF THE HYDROLOGIC CYCLE. PROCESSES THAT ARE OMITTED INCLUDE
C     SUBSURFACE AND GROUNDWATER ROUTING, SNOWMELT AND RIVER ROUTING.
C     THE PROGRAM WAS WRITTEN AT CSU BY KENNETH EGGERT, BRENT SPRONK,
C     BILL FULLERTON AND RICH MISKIMINS IN 1978 AND 1979. MODIFIED 8/79
C     FOR HP 1000 SYSTEM BY DREW KACHEL. UPDATED 1980 BY RICH MISKIMINS
C     TO REFLECT CHANGES.  SNOWMELT COMPONENT ADDED 1981.
C
      COMMON /ARAYS/        ARAT(2)     , AT(2)       , CAMLO(20)   ,
     1       CAMLT(20)    , CASET(20)   , CCOU(3)     , CCOUT(3)    ,
     2       DATE(5)      , DL(5)       , EC(5)       , ED1(40)     ,
     3       LASTD(12)    , MFIRS(12)   , MP(40)      , PERS7(11)   ,
     4       POROS(5)     , PSI(5)      , S(5)        , SAVE(5)     ,
     5       SINIT(5)     , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6       SW(5)        , THETA(5)    , TWATC(12)   , UP(5)       ,
     7       WETK(5)      , Z1(5)
```

Reproduced from best available copy.

```
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS         , B1          , C1          , CANCO       ,
     3        CANOF        , CANON       , CPO         , DATE1       ,
     4        DDRAI        , DRUN        , ET          , EXPON       ,
     5        F            , FDETC       , FDETO       , FILT        ,
     6        FLNET        , FO          , G           , GM          ,
     7        GRNCO        , GV          , HT          , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR        , K           , KJ          , KTP         ,
     A        LLDAY        , MAXDA       , MO          , MOREG       ,
     B        NALT         , NC          , NCAN        , NCAN1       ,
     C        NDAYS        , NDRN        , NM          , NRATN       ,
     D        NSED         , NUMDA       , PATR        , PER         ,
     E        PERRU        , PI          , PWP         , QI          ,
     F        R1           , R2          , R3          , R4          ,
     G        R5           , RDETC       , RESIS       , RESWA       ,
     H        RLIT         , RN          , RO          , RR1         ,
     I        RRR          , RX          , SEV         , SHIEL       ,
     J        SI           , SIGMA       , SIGRN       , SIMAX
      COMMON /BLOK2/        SIMIN         , SLAT        , STIME       ,
     1        SUN1         , SUN2        , TEMP1       , TEMP2       ,
     2        TOTVO        , TP          , TPRES       , TRCAN       ,
     3        U            , XL          , XN          , Z
      COMMON /BLOK5/        ASPP          , DASYR       , DATIS       ,
     1        DJ930
      COMMON /OMLCR/        AUTMC         , BSTMF       , CALDF       ,
     1        CDMAX        , CVDEN       , DREDY       , ENRLO       ,
     2        ENGBL        , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS        , PHASE       , PRWOU       , RCHRG       ,
     4        X(3)         , SMTM3       , TCOEF       , THSHD
      INTEGER               DREDY         , PHASE
      COMMON /SHINE/        ETDAY(12)     , NSLAS       , POTNT(52)   ,
     1        SADAT(52)    , SLASP(52)
      COMMON /ZBLOK/        NOPL
C
C     CHECK THE POSITION OF THE MULTI-YEAR FILES.
C
      NEOF = 1
      READ (51,41) IDUM
      IF (EOF(51) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (6,51)
      IF (NEOF .EQ. 0) CALL EXIT
      READ (31,41) IDUM
      IF (EOF(31) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (6,61)
      IF (NEOF .EQ. 0) CALL EXIT
      READ (33,41) IDUM
      IF (EOF(33) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (6,71)
      IF (NEOF .EQ. 0) CALL EXIT
C
C     INPUT WATERSHED LATITUDE AND PREPARE SLOPE-ASPECT CORRECTION
C     FACTORS FOR THIS LATITUDE.
C
      READ (85,81) NSLAS,SLAT
      READ (85,91) (SADAT(IMPD1),IMPD1 = 1,NSLAS)
      READ (85,91) DATIS
      READ (85,101) LSTUS,NDYSN
      READ (85,91) (ETDAY(IMPD2),IMPD2 = 1,12)
      PI = 3.1415926536
      DO 11 LP11 = 1,NSLAS
         CALL RADIT (SADAT(LP11),SLAT,0.0,0.0,DUM1,DUM2,POTNT(LP11),DUM3
     1   ,0.0)
   11 CONTINUE
C
C     INITIALIZE VARIABLES.
C
      AREA = 0.0
      IPRIN = 1
      JJJ = 0
      PER = 0.0
C
C     INPUT THE NUMBER OF PLANES (NPL) AND THE NUMBER OF 2-PLANE SUB-
C     WATERSHEDS (NWS).
C
      READ (4,101) NPL,NWS
      WRITE (13,101) NPL,NWS
      JK = 4
      WRITE (22,111) JK
```

```
C
C     SET TOTAL NUMBER OF SUBUNITS TO BE SIMULATED, AND THE NUMBER OF
C     PLANES (NOPL).
C
      NUMB = NWS + NPL
      NOPL = 2 * NWS + NPL
C
C     LOOP TO RUN YEARLY SIMULATION ON ALL -NUMB- SUBUNITS.
C
      DO 31 LP31 = 1,NUMB
C
C     INPUT THE SUBUNIT TYPE:  JPLAN = 1 FOR 1 PLANE, JPLAN = 2 FOR 2
C     PLANES.
C
         READ (4,101) JSTAT,JPLAN
         WRITE (13,101) JSTAT,JPLAN,IPRIN
C
C     RUN WATER BALANCE AND EXCESS PROGRAM FOR ENTIRE SIMULATION
C     PERIOD FOR EACH SUBUNIT, LP21 = 1,JPLAN.
C
         DO 21 LP21 = 1,JPLAN
            RSTHF = 35.0
            DREDY = 0
            IPLAN = JPLAN - LP21 + 1
            IJJ = IJJ + 1
            NDRN = 96
            PHASE = 0
            SMTM3 = 0.0
            X(1) = 0.0
            X(2) = 0.0
            X(3) = 0.0
            Z = 0.0
            CALL MAIN
            CALL GEOOU
            CALL NGEOU
   21    CONTINUE
         PER = PER + (PERRU/100.0) * SLLGT(1) * SLLGT(3)
         AREA = AREA + SLLGT(1) * SLLGT(3)
   31 CONTINUE
      PERRU = PER * 100.0/AREA
C
C     OUTPUT END-OF-SUBFILE MARK FOR FILE T53YYY.
C
      CALL WSHOU
      END FILE 53
C
C     ZERO FILL THE FILES EX1XXY,RADXXX,RUNYYY, AND TUMYYY, IF NEEDED.
C
      CALL ZEROU
C
C     TERMINATE THE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
   41 FORMAT (A2)
   51 FORMAT (20X,51HFILE STRUCTURE ERROR ON MANXXX,MESSAGE FROM HYDROL.
     1)
   61 FORMAT (20X,51HFILE STRUCTURE ERROR ON EDAXXX,MESSAGE FROM HYDROL.
     1)
   71 FORMAT (20X,51HFILE STRUCTURE ERROR ON VOIXXX,MESSAGE FROM HYDROL.
     1)
   81 FORMAT (I10,F10.4)
   91 FORMAT (8F10.4)
  101 FORMAT (3I10)
  111 FORMAT (I2)
      END
```

SUBROUTINE MAIN

```
      SUBROUTINE MAIN
      COMMON /ARAYS/          ARAT(2)       , AT(2)        , CANLO(20)    ,
     1        CANLI(20)      , CASE(20)     , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)        , DL(5)        , FC(5)        , FO1(40)      ,
     3        LASTD(12)      , NFIRS(12)    , NR(40)       , PERSZ(11)    ,
     4        POROS(5)       , PSI(5)       , S(5)         , SAVE(5)      ,
     5        SINIT(5)       , SIZE(11)     , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)          , THETA(5)     , TWATC(12)    , VP(5)        ,
     7        WETX(5)        , Z1(5)
      COMMON /BLOCK/          A1            , ADJTI        , ALBGR        ,
     1        ALBVE          , ALEAF        , ALMAX        , ALSR         ,
     2        ALSS           , R1           , C1           , CANCO        ,
     3        CANOF          , CANON        , CPO          , DATEJ        ,
     4        DDRAI          , DRUN         , ET           , EXPON        ,
     5        F              , FDETC        , FDETO        , FILT         ,
     6        FLNFT          , FO           , G            , GM           ,
     7        GRNCO          , GV           , HT           , IPLAN        ,
     8        ISTOR          , ITIME        , JJJ          , JPLAN        ,
     9        JSTAR          , K            , KJ           , KTP          ,
     A        LLDAY          , MAXDA        , MO           , MOBEG        ,
     B        NALT           , NC           , NCAN         , NCAN1        ,
     C        NDAYS          , NDRN         , NM           , NRAIN        ,
     D        NSED           , NUMDA        , PAIR         , PER          ,
     E        PERRU          , PI           , PWP          , QI           ,
     F        R1             , R2           , R3           , R4           ,
     G        R5             , RDETC        , RESIS        , RESWA        ,
     H        RLIT           , RN           , RO           , RR1          ,
     I        RRR            , RX           , SEV          , SHIEL        ,
     J        SI             , SIGMA        , SIGRN        , SIMAX
      COMMON /BLOK2/          SIMIN         , SLAT         , STIME        ,
     1        SUN1           , SUN2         , TEMP1        , TEMP2        ,
     2        TOTVO          , TP           , TPRES        , TRCAN        ,
     3        V              , XL           , XN           , Z
      COMMON /BLOK5/          ASPP          , DASYR        , DATIS        ,
     1        DJ930
      COMMON /EMBLK/          CCAL(51)      , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2)    , DP(51)       , DPI(51)      , EX(300)      ,
     2        EXNEW(200)     , EXTIM(300)   , EXTNF(200)   , MULTD(366)   ,
     3        PRECI(366)     , RAIN(200)    , RAINT(200)   , RFLCO(51,2)  ,
     4        RDLD(200)      , RTOLD(200)   , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)     , SPCH(51)     , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)     , THSOI(51)    , TINC(51)     , TSOIL(51)    ,
     7        VAPOR(366)     , VOL1(5,40)   , WATCO(51,2)
      COMMON /ONLCR/          AVTMC         , BSTMF        , CALDF        ,
     1        CDMAX          , CVDEN        , DREDY        , ENRLO        ,
     2        ENGBL          , FREWT        , LSTUS        , NDYSN        ,
     3        ONTRS          , PHASE        , PRWQV        , RCHRG        ,
     4        X(3)           , SMIM3        , TCOEF        , THSHD
      INTEGER                 DREDY         , PHASE
      COMMON /SHINE/          ETDAY(12)     , NSLAS        , POTNT(52)    ,
     1        SADAT(52)      , SLASF(52)
      COMMON /WTRBL/          ETFRM         , EVPTR        , GENRO        ,
     1        PRCIP          , RADIN        , RDLWN        , RDSWN        ,
     2        TMPMX          , TMPMN        , WTRIN
      DIMENSION               BALMO(13)     , DRNMO(13)    , ETMON(13)    ,
     1        FLTMO(13)      , PREMO(13)    , QIMON(13)    , RNFMO(13)    ,
     2        SEVMO(13)      , SFDMO(13)    , SIMON(13)    , SWTMO(13)
      CALL PARAM
      CALL SOIL
      CALL ENDAT
      CALL TEWAT
      DDRAI = 0.0
      DRUN = 0.0
      DTYME = 180.0
      ET = 0.01
      F = FC(5) * DL(5)
```

Reproduced from best available copy.

```
      ISTOR = 0
      ITIME = 0
      KJ = 0
      NDAYS = 1
      PERRU = 0.0
      PWP = - 1.0
      SI = 0.0
      SUN1 = SOLAR(1)
      SUN2 = SOLAR(1)
      TEMP1 = TEMP(1)
      TEMP2 = TEMP(1)
      DO 100 LP100 = 3,5
         VP(LP100) = VP(2)
  100 CONTINUE
      DO 110 LP110 = 1,5
         S(LP110) = VP(LP110) * DL(LP110)
  110 CONTINUE
      RCHRG = 0.0
      DO 120 LP120 = 1,2
         RCHRG = RCHRG + (FC(LP120) - WATCO(1,LP120)) * DL(LP120)
  120 CONTINUE
      RCHRG = RCHRG/2.54
      DO 130 LP130 = 1,NSLAS
         CALL RADIT (SADAT(LP130),SLAT,ASPP,SLOPE(1),DUM1,DUM2,SLASP(LP1
     1   30),DUM3,0.0)
         SLASP(LP130) = SLASP(LP130)/POTNT(LP130)
  130 CONTINUE
      WRITE (61,270)
      DO 250 LP250 = 1,NM
         MO = LP250 + MOBEG - 1
         IF (MO .GT. 12) MO = MO - 12
         BALMO(MO) = 0.0
         DRNMO(MO) = 0.0
         ETMON(MO) = 0.0
         FLTMO(MO) = 0.0
         PREMO(MO) = 0.0
         QIMON(MO) = 0.0
         RNFMO(MO) = 0.0
         SEVMO(MO) = 0.0
         SFDMO(MO) = 0.0
         SIMON(MO) = 0.0
         SWTMO(MO) = 0.0
         SIINL = SI
         SWINL = 0.0
         DO 140 LP140 = 1,5
            SWINL = SWINL + THETA(LP140)
  140    CONTINUE
         IF (LLDAY .NE. 0) WRITE (61,280) CASEI,MOBEG
         DO 240 LP240 = 1,5
            DRNWK = DRNMO(MO)
            ETWK = ETMON(MO)
            FLTWK = FLTMO(MO)
            PREWK = PREMO(MO)
            QIWK = QIMON(MO)
            RNFWK = RNFMO(MO)
            SEVWK = SEVMO(MO)
            SINT = SI
            SSTOR = 0.0
            DO 150 LP150 = 1,5
               SSTOR = SSTOR + THETA(LP150)
  150       CONTINUE
            NDAY = 7
            IF (LP240 .GT. 4) NDAY = LASTD(MO) - 28
            IF (NDAY .LE. 0) GO TO 210
            DO 200 LP200 = 1,NDAY
               FO = 0.0
               ITIME = ITIME + 1
               TEMP1 = TEMP2
               TEMP2 = TEMP(ITIME)
               TOTVO = 0.0
               TPRES = TEMP2
```

```
C
C     CALCULATE JULIAN DATE AND LEAF AREA INDEX VALUE FOR THAT DATE.
C
            DATEJ = FLOAT (NFIRS(MO) - 1 + 7 * (LP240 - 1) + LP200)
            CALL CANOP (DATEJ,ALEAF,CANCO)
            CANCO = (ALEAF/ALMAX) * CANCO
            RN = SOLAR(ITIME) * (1.0 - ALBVE) * CANCO
            SUN1 = SUN2
            CALL RDCMP (DATEJ,DASYR,RN,SUN2,MO,DUM4)
            RN = SUN2
            CALL RADIA
            IF (DATEJ .EQ. DJ930) DREDY = 0
            IF ((DATEJ .LE. DJ930) .AND. (PRWQV .LE. 0)) GO TO 160
            IF (KJ .EQ. 0) NDAYS = 1
            IF ((KJ .EQ. 0) .AND. (PRECI(ITIME) .GT. 0.0)) CALL IN
            KJ = KJ + 1
            IF (KJ .EQ. NDAYS) KJ = 0
            IEV = 0
            IF (ONTRS .GT. 0.0) IEV = 1
            CALL HYSNO
            IF (WTRIN .GT. 0.0) CALL RADIT (DATEJ,SLAT,0.0,0.0,DUM5,D
     1      UM6,DUM7,DTYME,WTRIN)
            ET = EVPTR * 2.54
            QI = ET * FLOAT (IEV)
            SEV = 0.0
            DDRAI = 0.0
            DRUN = GENRO * 2.54
            FLNET = 0.0
            GO TO 190
160         DO 170 LP170 = 1,2
               SINIT(LP170) = THETA(LP170)/(POROS(LP170) * DL(LP170))
170         CONTINUE
            CALL PROSP
            RCHRG = 0.0
            DO 180 LP180 = 1,2
               RCHRG = RCHRG + (SINIT(LP180) * POROS(LP180) - FC(LP18
     1         0) * DL(LP180))/2.54
180         CONTINUE
            PSL = PWP * 9.81E - 4
            IF (LLDAY .NE. 0) WRITE (61,290) ITIME,FO,QI,ET,PSL,SEV,D
     1      DRAI,(THETA(IMPD1),IMPD1 = 1,5)
190         CALL MOIOU
            CALL VOLOU
            DRNMO(MO) = DRNMO(MO) + DDRAI
            ETMON(MO) = ETMON(MO) + ET
            FLTMO(MO) = FLTMO(MO) + FO
            PREMO(MO) = PREMO(MO) + PRECI(ITIME)
            QIMON(MO) = QIMON(MO) + QI
            RNFMO(MO) = RNFMO(MO) + DRUN
            SEVMO(MO) = SEVMO(MO) + SEV
            SFDMO(MO) = SFDMO(MO) + FLNET
            DDRAI = 0.0
            DRUN = 0.0
            FLNET = 0.0
            QI = 0.0
200      CONTINUE
210      DRNWK = DRNMO(MO) - DRNWK
         ETWK = ETMON(MO) - ETWK
         FLTWK = FLTMO(MO) - FLTWK
         PREWK = PREMO(MO) - PREWK
         QIWK = QIMON(MO) - QIWK
         RNFWK = RNFMO(MO) - RNFWK
         SEVWK = SEVMO(MO) - SEVWK
         SSTOR = THETA(1) - SSTOR
         DO 220 LP220 = 2,5
            SSTOR = SSTOR + THETA(LP220)
220      CONTINUE
         SINT = SI - SINT
         ETOTW = ETWK + QIWK + SEVWK
         OUT = DRNWK + RNFWK
         BAL = PREWK - ETOTW - OUT - SSTOR - SINT
```

```
          SWTMO(MO) = - SWINL
          DO 230 LP230 = 1,5
             SWTMO(MO) = SWTMO(MO) + THETA(LP230)
230       CONTINUE
          SIMON(MO) = SI - SIINL
          BALMO(MO) = PREMO(MO) - ETMON(MO) - QIMON(MO) - SIMON(MO) -
     1    RNFMO(MO) - DRNMO(MO) - SWTMO(MO) - SEVMO(MO)
          ETOT = ETMON(MO) + SEVMO(MO) + QIMON(MO)
          OUTFL = RNFMO(MO) + DRNMO(MO)
          WRITE (61,300) LP240
          WRITE (61,310) PREWK,FLTWK,QIWK,ETWK,SEVWK,ETOTW,DRNWK,OUT,S
     1    TOR,BAL
240     CONTINUE
        WRITE (61,320) MO
        WRITE (61,310) PREMO(MO),FLTMO(MO),QIMON(MO),ETMON(MO),SEVMO(MO
     1  ),ETOT,DRNMO(MO),OUTFL,SWTMO(MO),BALMO(MO)
250 CONTINUE
    BALAN = 0.0
    DRAIN = 0.0
    ETOTA = 0.0
    FILTO = 0.0
    PTOTA = 0.0
    SEVAP = 0.0
    SOILW = 0.0
    TINCE = 0.0
    TRNOF = 0.0
    DO 260 LP260 = 1,NM
       KK260 = LP260 + MOBEG - 1
       IF (KK260 .GT. 12) KK260 = KK260 - 12
       BALAN = BALAN + BALMO(KK260)
       DRAIN = DRAIN + DRNMO(KK260)
       ETOTA = ETOTA + ETMON(KK260)
       FILTO = FILTO + FLTMO(KK260)
       PTOTA = PTOTA + PREMO(KK260)
       SEVAP = SEVAP + SEVMO(KK260)
       SOILW = SOILW + SWTMO(KK260)
       TINCE = TINCE + QIMON(KK260)
       TRNOF = TRNOF + RNFMO(KK260)
260 CONTINUE
    ETOT = ETOTA + SEVAP + TINCE
    OUTFL = DRAIN + TRNOF
    WRITE (61,330)
    WRITE (61,310) PTOTA,FILTO,TINCE,ETOTA,SEVAP,ETOT,DRAIN,OUTFL,SOIL
   1W,BALAN
    WRITE (53,340) (THETA(IMPD2),IMPD2 = 1,5)
    WRITE (6,350) (THETA(IMPD3),IMPD3 = 1,5)
    RETURN
C
C   VARIOUS FORMATS.
C
270 FORMAT (1H1,//20X,18HOUTPUT DESCRIPTION,//20X,78HVALUES FOR EACH J
   1ULIAN DATE(DAY) ARE PRINTED FOR:  INFILTRATION, INTERCEPTION,,/20X
   2,79HSTORAGE , TRANSPIRATION(ET) , PLANT , WATER POTENTIAL(PSI) , S
   3OIL EVAPORATION ,,/20X,80HDRAINAGE , AND THE WATER CONTENTS OF THE
   4 FIVE LAYERS.  THE PLANT WATER POTENTIAL/20X,44HUNITS ARE BARS.  A
   5LL OTHERS ARE CENTIMETERS.,/20X,73HWEEKLY , MONTHLY , AND ANNUAL S
   6UMMARIES ARE PRINTED FOR:  PRECIPITATION ,,/20X,80HINFILTRATION ,
   7INTERCEPTION,EVAPORATION , TRANSPIRATION, SOIL EVAPORATION, TOTAL/
   820X,80HEVAPORATION , DRAINAGE, OUTFLOW, SOIL STORAGE, AND MASS BAL
   9ANCE.  ALL VALUES ARE/,20X,15HIN CENTIMETERS.)
280 FORMAT (/20X,20A4,17H BEGINNING MONTH ,I3)
290 FORMAT (/20X,20HDAY INFILT    INTCPT,9X,6HET(CM),8X,7HPSI(CM),6X,9
   1HSOIL EVAP,7X,8HDRAINAGE/20X,I3,1X,F6.2,4X,F6.2,4(5X,E10.4)/35X,5H
   2SOIL1,10X,5HSOIL2,10X,5HSOIL3,10X,5HSOIL4,10X,5HSOIL5/25X,5(5X,E10
   3.4))
300 FORMAT (/20X,24HWEEKLY SUMMARY FOR WEEK ,I1)
310 FORMAT (/22X,78HPRECIPITATION  THROUGHFALL INTERCEPT-ET TRANSPIRAT
   1ION   SOIL EVAP     TOTAL ET/(22X,6(E13.5))/53X,8HDRAINAGE,6X,20HO
   2UTFLOW SOIL STORAGE,6X,7HBALANCE/(48X,4(E13.5)))
320 FORMAT (/20X,36HMONTHLY WATER BUDGET (CM) FOR MONTH ,I2)
330 FORMAT (/20X,24HANNUAL WATER BUDGET (CM))
340 FORMAT (5G10.5)
350 FORMAT (20X,5(F10.5,1X))
    END
```

SUBROUTINE CALIN (CLRIN)

```
      SUBROUTINE CALIN (CLRIN)
C
C     THIS PROGRAM UNIT COMPUTES THE EFFECTS OF THE CALORIC INPUT ON
C     THE SNOWPACK
C     HLDCP - THE FREE WATER HOLDING CAPACITY OF THE SNOWPACK
C                 (ASSUMED TO BE FOUR PERCENT OF THE WATER EQUIVALENT)
C
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVHEN       , DREDY       , ENGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWQV       , RCHKG       ,
     4        SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER                DREDY       , PHASE
      COMMON /WTRBL/        ETFRM       , EVPTR       , GENRO       ,
     1        PRCIP       , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX       , TMPMN       , WTRIN
C
C     ADD THESE CALORIES INTO THE ENERGY BALANCE
C
      ENGBL = ENGBL + CLRIN
C
C     SEE IF A CALORIE DEFICIT EXISTS IN THE PACK
C
      CMPAR = CLRIN - CALDF
      IF (CMPAR) 100,110,120
C
C     THERE IS A CALORIE DEFICIT, BUT THE INPUT DID NOT COMPLETELY
C      WIPE IT OUT.  ALL OTHER CONDITIONS ARE UNCHANGED
C
  100 CALDF =  - CMPAR
      RETURN
C
C     THE CALORIE DEFICIT WAS WIPED OUT, BUT ALL OTHER CONDITIONS ARE
C      UNCHANGED
C
  110 CALDF = 0.0
      RETURN
C
C     ANY DEFICIT WHICH DID EXIST WAS WIPED OUT.  COMPUTE THE POTENTIAL
C      MELT FROM THE REMAINING CALORIES (CALORIES/(80.0 * 2.54))
C
  120 PTMLT = CMPAR/203.2
      CALDF = 0.0
C
C     IF THE INPUT WAS ENOUGH TO MELT THE WHOLE PACK, CONTRIBUTE THE
C      WATER EQUIVALENT TO THE SNOWMELT AND ZERO ALL CONDITIONS
C
      IF (PTMLT.LT.(PRWQV - FREWT)) GO TO 130
      WTRIN = WTRIN + PRWQV
      PRWQV = 0.0
      FREWT = 0.0
      RETURN
C
C     DEPLETE THE ICE PACK BY THE AMOUNT MELTED AND CONTRIBUTE THAT
C      AMOUNT TO THE FREE WATER
C
  130 FREWT = FREWT + PTMLT
C
C     COMPUTE THE NEW HOLDING CAPACITY OF THE PACK AND COMPARE IT WITH
C      THE FREE WATER TO SEE IF SNOWMELT IS PRODUCED
C
      HLDCP = 0.04 * (PRWQV - FREWT)
      CMPAR = FREWT - HLDCP
      IF (CMPAR.LE.0.0) RETURN
C
C     THE SNOWMELT CONTRIBUTED IS IN - CMPAR -.  REDUCE THE FREE WATER
C      TO LEAVE A PRIMED PACK AND REDUCE THE PREDICTED WATER EQUIVALENT
C
```

```
      PRWQV = PRWQV - CMPAR
      WTRIN = WTRIN + CMPAR
      FREWT = HLDCP
      RETURN
      END
```

SUBROUTINE CALOS (CLOUT)

```
      SUBROUTINE CALOS (CLOUT)
C
C     THIS PROGRAM UNIT COMPUTES THE EFFECTS OF THE CALORIC LOSS ON
C     THE SNOWPACK
C
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWQV       , RCHRG       ,
     4        SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER                DREDY       , PHASE
C
C     ADD ALGEBRAICALLY THESE CALORIES INTO THE ENERGY BALANCE
C
      ENGBL = ENGBL + CLOUT
C
C     SEE IF THERE IS ANY FREE WATER IN THE PACK.  IF NOT, THE LOSS IS
C      JUST CONTRIBUTED TO THE CALORIC DEFICIT OF THE SNOWPACK.
C      REMEMBER THAT - CLOUT - IS NEGATIVE
C
      IF (FREWT.GT.0.0) GO TO 100
      CALDF = CALDF - CLOUT
      RETURN
C
C     COMPUTE THE CALORIC LOSS NECESSARY TO FREEZE ALL OF THE FREE WATER
C      (FREE WATER * 80.0 * 2.54)
C
  100 CALND = FREWT * 203.2
C
C     NOW COMPARE THAT NECESSARY LOSS WITH THE ACTUAL LOSS.  IF THEY ARE
C      THE SAME, THE FREE WATER IS WIPED OUT BUT NO OTHER CONDITIONS ARE
C      ALTERED
C
      CMPAR = CLOUT + CALND
      IF (CMPAR) 110,120,130
C
C     THE LOSS WAS MORE THAN ENOUGH TO FREEZE IT.  THE BALANCE CREATES
C      AN ENERGY DEFICIT IN THE PACK AND THE FREE WATER IS WIPED OUT
C
  110 CALDF =  - CMPAR
  120 FREWT = 0.0
      RETURN
C
C     ONLY PART OF THE FREE WATER FROZE.  COMPUTE THE BALANCE REMAINING
C      BALANCE = EXISTING FREE WATER - AMOUNT FROZEN, WHERE
C      AMOUNT FROZEN = CALORIES/(80.0 * 2.54)
C
  130 FREWT = FREWT + (CLOUT/203.2)
      RETURN
      END
```

SUBROUTINE CANOP (DAYJ, ALEAV, CANMX)

```
      SUBROUTINE CANOP (DAYJ,ALEAV,CANMX)
      COMMON /ARAYS/        ARAT(2)      , AT(2)       , CANLO(20)   ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)     , CCOVT(3)    ,
     2        DATE(5)      , DL(5)       , FC(5)       , FO1(40)     ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)      , PERSZ(11)   ,
     4        POROS(5)     , PSI(5)      , S(5)        , SAVE(5)     ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)        , THETA(5)    , TWATC(12)   , VP(5)       ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI       , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS         , A1          , C1          , CANCO       ,
     3        CANOF        , CANON       , CPO         , DATEJ       ,
     4        DDRAI        , DRUN        , ET          , EXPON       ,
     5        F            , FDETC       , FDETO       , FILT        ,
     6        FLNET        , FO          , G           , GM          ,
     7        GRNCO        , GV          , HT          , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR        , K           , KJ          , KTP         ,
     A        LLDAY        , MAXDA       , MO          , MOBEG       ,
     B        NALT         , NC          , NCAN        , NCAN1       ,
     C        NDAYS        , NDRN        , NK          , NRAIN       ,
     D        NSED         , NUMDA       , PAIR        , PER         ,
     E        PERRU        , PI          , PWP         , QI          ,
     F        R1           , R2          , R3          , R4          ,
     G        R5           , RDETC       , RESIS       , RESWA       ,
     H        RLIT         , RN          , RO          , RR1         ,
     I        RRR          , RX          , SEV         , SHIEL       ,
     J        SI           , SIGMA       , SIGRN       , SIMAX
      DO 100 LP100 = 2,NCAN
         KK100 = LP100
         IF (DAYJ .LE. CANLO(LP100)) GO TO 110
  100 CONTINUE
  110 ALEAV = CANLI(KK100 - 1) + ((CANLI(KK100) - CANLI(KK100 - 1))/(CAN
     1LO(KK100) - CANLO(KK100 - 1))) * (DAYJ - CANLO(KK100 - 1))
      CANMX = CCOV(NCAN1)
      IF (NCAN1 .EQ. 1) GO TO 130
      DO 120 LP120 = 2,NCAN1
         IF (DAYJ .GT. CCOVT(LP120)) GO TO 120
         CANMX = CCOV(LP120 - 1) + ((CCOV(LP120) - CCOV(LP120 - 1))/(CCO
     1   VT(LP120) - CCOVT(LP120 - 1))) * (DAYJ - CCOVT(LP120 - 1))
         GO TO 130
  120 CONTINUE
  130 CONTINUE
      RETURN
      END
```

SUBROUTINE CANVP

```
      SUBROUTINE CANVP
C
C     COMPUTE THE EVAPORATION FROM THE INTERCEPTED SNOW AS A FUNCTION OF
C      THE CANOPY COVER DENSITY
C
      COMMON /ONLCR/          AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX        , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1        , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS        , PHASE       , PRWQV       , RCHRG       ,
     4        SMTM1(3)     , SMTM3       , TCOEF       , THSHD
      INTEGER                 DREDY       , PHASE
      COMMON /WTRBL/          ETFRM       , EVPTR       , GENRO       ,
     1        PRCIP        , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX        , TMPMN       , WTRIN
      ETFRM = 1.0
      EVPTR = EVPTR/CVDEN
      ONTRS = ONTRS - EVPTR
      IF (ONTRS) 100,110,110
  100 EVPTR = ONTRS + EVPTR
      ONTRS = 0.0
  110 RETURN
      END
```

SUBROUTINE DIFMD

```
      SUBROUTINE DIFMD
C
C     THIS PROGRAM UNIT WAS DERIVED FROM PROGRAM SIMTEM, A SNOWPACK
C      TEMPERATURE DIFFUSION MODEL DEVELOPED BY LEAF (1970 STUDY PLAN
C      FS-RM-1602, NO. 224, RMF+RES).  USING THE AVERAGE SURFACE TEMP
C      AND THE GROUND TEMP AS BOUNDARY CONDITIONS, THE NEW AVERAGE
C      SNOWPACK TEMPERATURE IS CALCULATED
C
      COMMON /ONLCR/          AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX        , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1        , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS        , PHASE       , PRWQV       , RCHRG       ,
     4        SMTM1(3)     , SMTM3       , TCOEF       , THSHD
      INTEGER                 DREDY       , PHASE
      COMMON /WTRBL/          ETFRM       , EVPTR       , GENRO       ,
     1        PRCIP        , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX        , TMPMN       , WTRIN
C
C     DICTIONARY
C
C     CONS1 - THE FIRST CONSTANT IN THE EQUATION FOR THE SIMULATION
C     CONS2 - THE SECOND CONSTANT IN THE EQUATION FOR THE SIMULATION
C     H - THE DISTANCE BETWEEN NODES (CORRESPONDS TO THE -H- IN THE
C                 STUDY PLAN)
C
C     COMPUTE THE DENSITY OF THE SNOWPACK (THE FUNCTION WAS DERIVED FROM
C      OBSERVED CONDITIONS ON THE FRASER EXPERIMENTAL FOREST)
C
      DNSTY = (EXP((0.0179 * PRWQV) + 3.02))/100.0
C
C     COMPUTE THE DISTANCE BETWEEN THE TWO NODES IN CENTIMETERS
C     DEPTH = PRWQV/DNSTY
C     H = (DEPTH/2) * 2.54
C
      H = (PRWQV/DNSTY) * 1.27
C
```

```
C     THE THERMAL DIFFUSIVITY IS CALCULATED FROM THE FUNCTION
C      KV = 0.01/((2.751 - DNSTY)* 0.48).  MATHEMATICAL STABILITY
C      REQUIRES THAT THE VALUE OF THE QUANTITY (INTERVAL IN SECONDS *
C      KV/H**2) BE LESS THAN 0.5.  WHEN A 24 HOUR INTERVAL IS USED, THE
C      SNOW DEPTH MUST EXCEED 30 INCHES (20 PERCENT DENSITY) TO ACHIEVE
C      STABILITY.  IN ORDER TO INSURE STABILITY WITH SOMEWHAT SHALLOWER
C      PACKS (ABOUT 18 INCHES), THE DAY IS DIVIDED INTO 2 TIME INTERVALS
C      OF 12 HOURS (43200 SECONDS)
C     CONS1 = (43200 * 0.01/((2.751 - DNSTY) * 0.48))/H**2
C
      CONS1 = 900.0/((2.751 - DNSTY) * H * H)
C
C     THE MINIMUM WATER EQUIVALENT WHICH WILL ACHIEVE STABILITY USING
C      THE ABOVE DENSITY FUNCTION IS 4.7 INCHES
C
      IF (CONS1 - 0.5) 110,100,100
C
C     THE MODEL IS UNSTABLE - INDICATE THAT IT IS NOT READY FOR USE NOW.
C      (IT MAY BE INITIALIZED AGAIN BY AN OBSERVED PACK TEMPERATURE CARD
C      AND STABILITY WILL BE ASCERTAINED FROM THE WATER EQUIVALENT AT
C      THAT TIME)
C
  100 DREDY = 0
      RETURN
C
C     GET THE SECOND CONSTANT
C
  110 CONS2 = 1.0 - CONS1 - CONS1
C
C     PERFORM THE SIMULATION IN TWO PARTS (ONE FOR EACH 12 HOUR PERIOD).
C       SMTM1 - HOLDS THE THREE TEMPERATURES FROM THE PREVIOUS INTERVAL
C      THAT ARE NEEDED TO SIMULATE SMTM2, THE NODE AT THE CENTER OF
C      THE PACK.  SIMULATE THE FIRST 12 HOURS NOW
C
      SMTM2 = (CONS1 * (SMTM1(1) + SMTM1(3))) + (CONS2 * SMTM1(2))
C
C     THE AVERAGE SNOWPACK TEMPERATURE IS THE AVERAGE OF THE 2 NODES
C      (MIDDLE AND GROUND) IN BOTH INTERVALS.  GROUND TEMPERATURE IS
C      CONSTANT, SO START THE AVERAGE NOW
C
      SMTM3 = SMTM1(3) + SMTM1(3) + SMTM2
C
C     RESET - SMTM1 - TO THE TEMPERATURES OF THE INTERVAL JUST SIMULATED
C      FOR USE IN THE SECOND 12 HOUR INTERVAL SIMULATION.  THE SURFACE
C      AIR TEMPERATURE IS SPLIT INTO A LOW AVERAGE ((MEAN + MIN)/2) AND
C      A HIGH AVERAGE ((MEAN + MAX)/2) FOR USE WITH THE TWELVE HOUR
C      INTERVALS.  USE THE LOW AVERAGE NOW
C
      SMTM1(1) = AMIN1(0.0,(((TMPMN - 32.0) * 5.0/9.0) + AVTMC)/2.0)
      SMTM1(2) = SMTM2
C
C     SIMULATE THE SECOND 12 HOURS AND COMPUTE THE AVERAGE SNOWPACK
C      TEMPERATURE
C
      SMTM2 = (CONS1 * (SMTM1(1) + SMTM1(3))) + (CONS2 * SMTM1(2))
      SMTM3 = (SMTM3 + SMTM2)/4.0
C
C     RESET - SMTM1 - USING THE HIGH AVERAGE FOR USE ON THE FIRST
C      INTERVAL OF THE NEXT DAY
C
      SMTM1(1) = AMIN1(0.0,(((TMPMX - 32.0) * 5.0/9.0) + AVTMC)/2.0)
      SMTM1(2) = SMTM2
C
C     CHECK TO SEE IF THE GROUND TEMPERATURE SHOULD BE RAISED
C
      IF (SMTM3 + 1.5) 150,130,120
  120 IF (SMTM3 + 0.5) 130,140,140
  130 IF (SMTM1(3).LT. - 0.5) SMTM1(3) =  - 0.5
      RETURN
  140 SMTM1(3) = 0.0
  150 RETURN
      END
```

SUBROUTINE ENDAT

```
      SUBROUTINE ENDAT
C
C     THIS PROGRAM UNIT IS THE INPUT FOR ENVIRONMENTAL DATA AND HAS
C     BEEN WRITTEN TO BE COMPATIBLE WITH THE WATERSHED TRANSPORT MODEL
C     UNDER DEVELOPMENT BY D.D.HUFF OF THE LAKE WINGRA SITE, EASTERN
C     DECIDUOUS FOREST BIOME, IBP.
C
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , B1          , C1           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DDRAI        , DRUN        , ET           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GH           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , MAXDA       , MO           , MOBEG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RR1          ,
     I        RRR          , RX          , SEV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
      COMMON /BLOK5/        ASPP         , DASYR        , DATIS        ,
     1        DJ930
      COMMON /EMBLK/        CCAL(51)     , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2)  , DP(51)      , DPI(51)      , EX(300)      ,
     2        EXNEW(200)   , EXTIM(300)  , EXTNE(200)   , MULTD(366)   ,
     3        PRECI(366)   , RAIN(200)   , RAINT(200)   , RELCO(51,2)  ,
     4        RDLD(200)    , RTOLD(200)  , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)   , SPCH(51)    , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)   , THSOI(51)   , TINC(51)     , TSOIL(51)    ,
     7        VAPOR(366)   , VOLI(5,40)  , WATCO(51,2)
      DIMENSION             IRP(11)      , LEAP(12)     , NORMA(12)    ,
     1        RP(11)
      DATA    NORMA/31,26,31,30,31,30,31,31,30,31,30,31/
C
C     LASTD IS AN ARRAY CONTAINING THE NUMBER OF DAYS IN EACH MONTH.
C     MOBEG IS THE MONTH (NUMERICAL) IN WHICH THE SIMULATION STARTS.
C     THE DATA ARE INPUT IN THE ORDER:
C        1. DAILY TOTAL PRECIPITATION (INCHES).
C        2. MULTIPLE DAY STORM INDEX.
C        3. DAILY TOTAL SOLAR RADIATION (LANGLEYS).
C        4. DAYTIME MEAN VAPOR PRESSURE (MILLIBARS).
C        5. DAYTIME MEAN TEMPERATURE (DEGREES FARENHEIT).
C     THE DATA ARE ON CARDS CONTAINING THE FOLLOWING INFORMATION:
C        1. IMO = THE NUMERICAL VALUE OF THE MONTH.
C        2. IDY = THE CARD NUMBER (1,2, OR 3) FOR THE MONTH.  EACH
C                 MONTH HAS THREE DATA CARDS.
C        3. RP  = AN ARRAY IN WHICH UP TO 11 PIECES OF DATA ARE STORED
C                 TEMPORARILY.
C        4. IRP = AN ARRAY IN WHICH UP TO 11 PIECES OF DATA ARE STORED
C                 TEMPORARILY.
C     CASEI IS AN ALPHANUMERIC PROBLEM DEFINITION AND WILL BE THE
C     HEADING UPON OUTPUT.
C
```

Reproduced from best available copy.

```
      READ (31,180) CASEI
      WRITE (61,190) CASEI
      READ (31,200) (LEAP(IMPD1),IMPD1 = 1-12),NM
      NNM = NM * 3
      KK = 0
      NFIRS(1) = 1
      NFIRS(2) = NFIRS(1) + NORMA(1)
      LASTD(1) = NORMA(1)
      LASTD(2) = NORMA(2) + LEAP(2)
      DO 100 LP100 = 3,12
         NFIRS(LP100) = NFIRS(LP100 - 1) + NORMA(LP100 - 1)
         LASTD(LP100) = NORMA(LP100)
  100 CONTINUE
      DO 110 LP110 = 3,12
         NFIRS(LP110) = NFIRS(LP110) + LEAP(LP110)
  110 CONTINUE
C
C     CALCULATE JULIAN DATES FOR 30 SEPTEMBER AND 31 DECEMBER.
C
      DJ930 = FLOAT (NFIRS(9) + 29)
      DASYR = FLOAT (NFIRS(12) + 30)
      DO 150 LP150 = 1,6
         KDAY = 0
         NOMO = 0
  120    IF (LP150 .NE. 2) READ (31,210) IMO,IDY,RP
         IF (LP150 .EQ. 2) READ (31,220) IMO,IDY,IRP
         IF (KK .NE. 0) GO TO 130
         MOBEG = IMO
         WRITE (61,230) MOBEG,NM,LASTD
         IF (JJJ .NE. 1) GO TO 130
         IF ((0 .GE. NALT) .OR. (5 .LE. NALT)) WRITE (6,240)
         IF ((0 .GE. NALT) .OR. (5 .LE. NALT)) CALL EXIT
         JSTAR = NFIRS(MOBEG)
         WRITE (90) NALT,JSTAR
  130    KK = 1
         NOMO = NOMO + 1
         LAST = 11
         IF (IDY .GT. 2) LAST = LASTD(IMO) - 22
         DO 140 LP140 = 1,LAST
            KDAY = KDAY + 1
            IF (LP150 .EQ. 1) PRECI(KDAY) = RP(LP140) * 2.54
            IF (LP150 .EQ. 2) MULTD(KDAY) = IRP(LP140)
            IF (LP150 .EQ. 3) SOLAR(KDAY) = RP(LP140)
            IF (LP150 .EQ. 4) VAPOR(KDAY) = RP(LP140) * 0.001
            IF (LP150 .EQ. 5) TEMPL(KDAY) = (RP(LP140) - 32.0) * 5.0/9.0
            IF (LP150 .EQ. 6) TEMPH(KDAY) = (RP(LP140) - 32.0) * 5.0/9.0
  140    CONTINUE
         IF (NOMO .LT. NNM) GO TO 120
         IF (LP150 .EQ. 1) MAXDA = KDAY
  150 CONTINUE
      WRITE (61,250) (PRECI(IMPD2),IMPD2 = 1,MAXDA)
      WRITE (61,260) (MULTD(IMPD3),IMPD3 = 1,MAXDA)
      WRITE (61,270) (SOLAR(IMPD4),IMPD4 = 1,MAXDA)
      WRITE (61,280) (VAPOR(IMPD5),IMPD5 = 1,MAXDA)
      WRITE (61,290) (TEMPL(IMPD6),IMPD6 = 1,MAXDA)
      WRITE (61,300) (TEMPH(IMPD7),IMPD7 = 1,MAXDA)
      IF (JJJ .NE. 1) GO TO 160
      IF (NALT .EQ. 1) WRITE (54) MAXDA
      IF (NALT .EQ. 2) WRITE (55) MAXDA
      IF (NALT .EQ. 3) WRITE (56) MAXDA
      IF (NALT .EQ. 4) WRITE (57) MAXDA
  160 DO 170 LP170 = 1,MAXDA
         TEMP(LP170) = (TEMPL(LP170) + TEMPH(LP170))/2.0
  170 CONTINUE
      WRITE (61,310) (TEMP(IMPD8),IMPD8 = 1,MAXDA)
      WRITE (18) (TEMP(IMPD8),IMPD8 = 1,MAXDA)
      RETURN
C
C     VARIOUS FORMATS.
C
  180 FORMAT (20A4)
  190 FORMAT (1H1,15X,20A4)
  200 FORMAT (13I5)
```

```
210 FORMAT (9X,I2,I1,11F10.7)
220 FORMAT (9X,I2,I1,11I10)
230 FORMAT (/20X,28HSIMULATION BEGINS WITH MONTH,50X,I2/20X,32HNUMBER
   1OF MONTHS BEING SIMULATED,46X,I2,/20X,15HDAYS PER MONTH.,/(16X,12I
   27))
240 FORMAT (/20X,73HTHE ALTERNATIVE NUMBER IS IN ERROR.  IT MUST BE EI
   1THER 1,2,3,OR 4.  IT IS,I7/)
250 FORMAT (//20X,28HPRECIPITATION  (CENTIMETERS),/(20X,8(E10.4,2X)))
260 FORMAT (//20X,33HMULTIPLE DAY RAIN STORM INDICATOR,/(20X,8(I10,2X)
   1))
270 FORMAT (//20X,25HSOLAR  (LANGLEYS PER DAY)/(20X,8(E10.4,2X)))
280 FORMAT (//20X,13HVAPOR  (BARS),/(20X,8(E10.4,2X)))
290 FORMAT (//20X,29HLOW TEMPERATURE  (CENTIGRADE),/(20X,8(E10.4,2X)))
300 FORMAT (//20X,29HHIGH TEMPERATURE (CENTIGRADE),/(20X,8(E10.4,2X)))
310 FORMAT (//20X,32HAVERAGE TEMPERATURE (CENTIGRADE),/(20X,8(E10.4,2X
   1)))
    END
```

SUBROUTINE EVAL (X, FX)

```
      SUBROUTINE EVAL (X,FX)
C
C     THIS PROGRAM UNIT DEFINES THE RESISTANCE PARAMETERS FOR THE
C     ELECTRIC AND IT ESTIMATES EVAPOTRANSPIRATION.
C
      COMMON /ARAYS/        ARAT(2)      , AT(2)       , CANLO(20)   ,
     1        CANLI(20)   , CASEI(20)    , CCOV(3)     , CCOVT(3)    ,
     2        DATE(3)     , DL(5)        , FC(5)       , FOI(40)     ,
     3        LASTD(12)   , NFIRS(12)    , NR(40)      , PERSZ(11)   ,
     4        POROS(5)    , PSI(5)       , S(5)        , SAVE(5)     ,
     5        SINIT(5)    , SIZE(11)     , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)       , THETA(5)     , TWATC(12)   , VP(5)       ,
     7        WETK(5)     , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF        , ALMAX       , ALSR        ,
     2        ALSS        , B1           , C1          , CANCO       ,
     3        CANOF       , CANON        , CPV         , DATEJ       ,
     4        DDRAI       , DRUN         , ET          , EXPON       ,
     5        F           , FDETC        , FDETO       , FILT        ,
     6        FLNET       , FO           , G           , GM          ,
     7        GRNCO       , GV           , HT          , IPLAN       ,
     8        ISTOR       , ITIME        , JJJ         , JPLAN       ,
     9        JSTAR       , K            , KJ          , KTP         ,
     A        LLDAY       , MAXDA        , MO          , MOREG       ,
     B        NALT        , NC           , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN         , NM          , NRAIN       ,
     D        NSED        , NUMDA        , PAIR        , PER         ,
     E        PERRU       , PI           , PWP         , QI          ,
     F        R1          , R2           , R3          , R4          ,
     G        R5          , RDETC        , RESIS       , RESWA       ,
     H        RLIT        , RN           , RO          , RR1         ,
     I        RRR         , RX           , SFV         , SHIEL       ,
     J        SI          , SIGMA        , SIGRN       , SIMAX
      COMMON /BLOK2/        SIMIN        , SLAT        , STIME       ,
     1        SUN1        , SUN2         , TEMP1       , TEMP2       ,
     2        TOTVO       , TP           , TPRES       , TRCAN       ,
     3        V           , XL           , XN          , Z
      COMMON /BLOK3/        ETONM        , ETNUM       , IC          ,
     1        IVAP        , RDENM        , RNUM
      PPP = 9.81E - 4 * X + 15.0
      IF (PPP .LT. 0.0) RRR = 200.0
      IF (PPP .GT. 15.0) RRR = RO
      IF ((PPP .LT. 0.0) .OR. (PPP .GT. 15.0)) GO TO 100
      RRR = RO + (200.0 - RO) * EXP ( - 0.5 * PPP)
C
C     DETERMINE ELECTRICAL ANALOG PARAMETERS.
C
  100 IF (IC .NE. 0) GO TO 110
      IC = 1
      RLIT = 200000.0
      R3RL = R3 + RLIT
      D = R1 + R2 + R5
```

```
      RT1 = R1 * R5/D
      RT2 = R1 * R2/D
      RT3 = R2 * R5/D + R4 + RR1
      D = RT1 + RT3 + R3RL
      RRA = RT2 + RT1 * RT3/D
      RRB = R3RL * RT3/D
      RRC = R3RL * RT1/D
      D = RRA + RRC
      RNUM = (RRA * PSI(1) + RRC * PSI(2))/D
      RDENM = RRB + RRA * RRC/D
  110 RX = RRR
C
C     DETERMINE EVAPOTRANSPIRATION.
C
      CALL EVAP (RN,G,TEMP2,ETEVL,IVAP)
      FX =  (RNUM - X)/RDENM - ETEVL
      RETURN
      END
```

SUBROUTINE EVAP (RNEVP, GEVAP, TEVAP, ETEVP, IEVAP)

```
      SUBROUTINE EVAP (RNEVP,GEVAP,TEVAP,ETEVP,IEVAP)
C
C     THIS PROGRAM UNIT DETERMINES THE EVAPOTRANSPIRATION DEMAND FROM
C     ENVIRONMENTAL PARAMETERS.
C
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1       ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2       ALSS         , B1          , C1          , CANCO       ,
     3       CANOF        , CANON       , CPO         , DATEJ       ,
     4       DDRAI        , DRUN        , ET          , EXPON       ,
     5       F            , FDETC       , FDETO       , FILT        ,
     6       FLNET        , FO          , G           , GM          ,
     7       GRNCO        , GV          , HT          , IPLAN       ,
     8       ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9       JSTAR        , K           , KJ          , KTP         ,
     A       LLDAY        , MAXDA       , MO          , MOBEG       ,
     B       NALT         , NC          , NCAN        , NCAN1       ,
     C       NDAYS        , NDRN        , NM          , NRAIN       ,
     D       NSED         , NUMDA       , PAIR        , PER         ,
     E       PERRU        , PI          , PWP         , Q1          ,
     F       R1           , R2          , R3          , R4          ,
     G       R5           , RDETC       , RESIS       , RESWA       ,
     H       RLIT         , RN          , RO          , RR1         ,
     I       RRR          , RX          , SEV         , SHIEL       ,
     J       SI           , SIGMA       , SIGRN       , SIMAX
      COMMON /BLOK2/        SIMIN       , SLAT        , STIME       ,
     1       SUN1         , SUN2        , TEMP1       , TEMP2       ,
     2       TOTVO        , TP          , TPRES       , TRCAN       ,
     3       V            , XL          , XN          , Z
      COMMON /BLOK3/        ETDNM       , ETNUM       , IC          ,
     1       IVAP         , RDENM       , RNUM
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
     1       DEGSA(51,2)  , DP(51)      , DPI(51)     , EX(300)     ,
     2       EXNEW(200)   , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3       PRECI(366)   , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4       ROLD(200)    , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5       SOLAR(366)   , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6       TEMPL(366)   , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
```

```
     7        VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
      REAL                 MIX
C
C     COMPUTE BOUNDARY LAYER RESISTANCE (REFERENCE).
C
      RA = 3.3 * XL *  * 0.3/V *  * 0.5
      TT = TEVAP + 273.16
C
C     THE SATURATION VAPOR PRESSURE (IN ATMOSPHERES) AND ITS DERIVATIVE
C     WITH RESPECT TO TEMPERATURE (ATMOSPHERES/DEGREES KELVIN) ARE
C     COMPUTED IN SATVP USING THE GOFF-GRATCH FORMULA.
C
C     PARAMETERS.
C        ESTAR = SATURATION VAPOR PRESSURE.
C        DEDT  = DERIVATIVE OF SATURATION VAPOR PRESSURE WITH RESPECT
C                TO TEMPERATURE.
C
      IF (IEVAP .NE. 0) GO TO 100
      CALL SATVP (TT,ESTAR,DEDT)
      ESTAR = 1.0132 * ESTAR
      TTDEN = 0.1/(0.461 * TT)
      E = VAPOR(ITIME)
      IF (E .GT. ESTAR) E = ESTAR
      MIX = 0.622 * E/(PAIR - E)
      RHOAI = 0.1 * PAIR * (1.0 + MIX)/(0.287 * (1.0 + 1.61 * MIX) * TT)
      HT = 597.3 - 0.56 * TEMP(ITIME)
C
C     ETEVP = EVAPOTRANSPIRATION DEMAND.
C
      FAC = ALEAF/(1.0 + ALEAF/3.0)
      FACP1 = FAC + 1.0
      RMLTP = 1.0132 * DEDT * TTDEN/((1.0 + FAC * SIGMA) * RHOAI * CPO *
     1(1.0 + 0.8 * MIX))
      ETNUM = FACP1 * ((RNEVP - GEVAP) * RMLTP + 86400.0 * (ESTAR - E) *
     1 TTDEN/RA)
      ETDNM = 1 + HT * FACP1 * RMLTP
  100 ETEVP = ETNUM/(ETDNM + RX/RA)
      IF (ETEVP .LT. 0.0) ETEVP = 0.0
      RETURN
      END
```

SUBROUTINE EVTRN

```
      SUBROUTINE EVTRN
C
C     COMPUTE THE EVAPORATION AND TRANSPIRATION DURING THE GROWING
C      SEASON
C
C     DICTIONARY
C     AVBLE - THE FACTOR FOR ADJUSTING THE EVAPOTRANSPIRATION FOR
C                 AVAILABLE SOIL WATER
C     CANRF - THE FACTOR FOR ADJUSTING THE EVAPOTRANSPIRATION
C                 FOR CANOPY REFLECTIVITY
C
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX        , CVDEN       , DREDY       , ENGBL       ,
     2         ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3         ONTRS       , PHASE       , PRWQV       , RCHRG       ,
     4         SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER                DREDY       , PHASE
      COMMON /WTRBL/         ETFRM       , FVPTR       , GENRO       ,
```

```
     1        PRCIP       , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX       , TMPMN       , WTRIN
      ETFRM = 4.0
C
C     GET THE ADJUSTMENT FACTOR FOR AVAILABLE SOIL WATER.  IF THE
C      RECHARGE REQUIREMENTS ARE SATISFIED (I.E., FIELD CAPACITY HAS
C      BEEN REACHED), MAXIMIZE THE ADJUSTMENT FACTOR
C
      IF (RCHRG) 110,110,100
  100 AVBLE = 1.0
      GO TO 170
C
C     IN FORESTED AREAS, USE THE MAXIMIZED FACTOR UNTIL THE RECHARGE
C      REQUIREMENTS ARE HALF OF THE FIELD CAPACITY.  AT THAT POINT, USE
C      THE LINEAR FUNCTION Y = MX + B, WHERE B = 0.0 TO GET THE FACTOR
C
  110 IF (CVDEN) 140,140,120
  120 IF (RCHRG + 2.65) 130,100,100
  130 AVBLE = 0.377 * (5.3 + RCHRG)
      GO TO 170
C
C     IN CLEARINGS, ASSUME THAT EVAPOTRANSPIRATION DECREASES LINEARLY
C      FROM THE MAXIMIZED VALUES AT FIELD CAPACITY TO ZERO AT
C      THREE-FOURTHS OF FIELD CAPACITY
C
  140 IF (RCHRG + 1.325) 160,160,150
  150 AVBLE = (0.755 * (5.3 + RCHRG)) - 3.0
      GO TO 170
  160 EVPTR = 0.0
      RETURN
C
C     COMPUTE THE FACTOR FOR ADJUSTING THE EVAPOTRANSPIRATION FOR CANOPY
C      REFLECTIVITY (PROTECT AGAINST DIVISION BY ZERO - JUST DEFINE THE
C      FACTOR FOR CLEARINGS AS THE MINIMUM VALUE)
C
  170 IF (CDMAX) 180,180,190
  180 CANRF = 0.5
      GO TO 220
C
C     COMPARE THE COVER DENSITY WITH THE MAXIMUM (CHECK FOR THINNING)
C
  190 IF (CVDEN - (CDMAX/3.0)) 200,200,210
C
C     FOR COVER DENSITIES THINNED TO ONE-THIRD OF THE MAXIMUM OR LESS,
C      USE THIS RELATIONSHIP
C     CANRF = 1.0 - (0.5 - ((0.75*CD)/CDMX))
C
  200 CANRF = 0.5 + ((0.75 * CVDEN)/CDMAX)
      GO TO 220
C
C     FROM MAXIMUM COVER DENSITY DOWN TO ONE-THIRD OF THAT VALUE, USE
C      THE FOLLOWING RELATIONSHIP
C     CANRF = 1.0 - (0.25 - ((0.15/(0.67 * CDMX)) * (CD-(0.33 * CDMX))))
C
  210 CANRF = 0.75 + ((0.15/(0.67 * CDMAX)) * (CVDEN - (0.33 * CDMAX)))
C
C     PERFORM THE ADJUSTMENTS
C
  220 EVPTR = EVPTR * AVBLE * CANRF
C
C     SEE IF THE EVAPOTRANSPIRATION WILL DEPLETE THE MANTLE STOARGE
C      BELOW THE WILTING POINT.  IF SO, ALTER THE EVAPOTRANSPIRATION
C      ACCORDINGLY
C
      IF (RCHRG - EVPTR + 5.3) 230,240,240
  230 EVPTR = RCHRG + 5.3
      RCHRG =  - 5.3
      RETURN
  240 RCHRG = RCHRG - EVPTR
      RETURN
      END
```

```
      SUBROUTINE EXCOU
      COMMON /ARAYS/          ARAT(2)      , AT(2)        , CAMLO(20)    ,
     1        CAMLI(20)      , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)        , DL(5)       , FC(5)        , FO1(40)      ,
     3        LASTD(12)      , NFIPS(12)   , NR(40)       , PERS7(11)    ,
     4        POPOS(5)       , PSI(5)      , S(5)         , SAME(5)      ,
     5        SINIT(5)       , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)          , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)        , Z1(5)
      COMMON /BLOCK/          A1           , ADJTI        , ALBGR        ,
     1        ALBVE          , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS           , B1          , C1           , CANCO        ,
     3        CANOF          , CANON       , CPO          , DATEJ        ,
     4        DDRAI          , DRUN        , ET           , EXPON        ,
     5        F              , FDETC       , FDETO        , FILT         ,
     6        FLNET          , FO          , G            , GM           ,
     7        GRNCO          , GV          , HT           , IPLAN        ,
     8        ISTOR          , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR          , K           , K1           , KTP          ,
     A        LLDAY          , MAXDA       , MD           , MDREG        ,
     B        MALT           , MC          , MCAN         , MCAN1        ,
     C        MDAYS          , MDRN        , MM           , MRAIN        ,
     D        MSED           , NUMDA       , PAIR         , PER          ,
     E        PERRU          , PI          , PWP          , QI           ,
     F        R1             , R2          , R3           , R4           ,
     G        R5             , RDETC       , RESIS        , RESMA        ,
     H        RLIT           , RM          , RO           , RR1          ,
     I        RRR            , RX          , SEV          , SHIEL        ,
     J        SI             , SIGMA       , SIGRN        , SIMAX
      COMMON /BLOK2/          SIMIN        , SLAT         , STIME        ,
     1        SUM1           , SUM2        , TEMP1        , TEMP2        ,
     2        TOTVO          , TP          , TPRES        , TRCAN        ,
     3        U              , XL          , XN           , Z
      COMMON /EMBLK/          CCAL(51)     , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2)    , DP(51)      , DPI(51)      , EX(300)      ,
     2        EXNEW(200)     , EXTIM(300)  , EXTNE(200)   , MULTD(366)   ,
     3        PRECI(366)     , RAIN(200)   , RAINT(200)   , RELCO(51,2)  ,
     4        ROLD(200)      , RTOLD(200)  , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)     , SPCH(51)    , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)     , THSOI(51)   , TINC(51)     , TSOIL(51)    ,
     7        VAPOR(366)     , VOL1(5,40)  , WATCO(51,2)
      K1 = K - 1
      J1 = 0
      DO 110 LP110 = 1,K1
         IF ((EX(LP110) .GT. 0.0) .OR. (EX(LP110 + 1) .GT. 0.0)) GO TO 1
     1   00
         GO TO 110
100      J1 = J1 + 1
         EXNEW(J1) = EX(LP110)
         EXTNE(J1) = EXTIM(LP110)
110   CONTINUE
      K = J1 + 1
      EXNEW(K) = 0.0
      EXTNE(K) = 1.0E38
      SUM = EXTNE(1) * EXNEW(1)
      IF (J1 .LE. 1) GO TO 130
      DO 120 LP120 = 2,J1
         SUM = EXNEW(LP120) * (EXTNE(LP120) - EXTNE(LP120 - 1)) + SUM
120   CONTINUE
130   SUM = SUM/(EXTNE(J1) * 6000.0)
      AL = (8.0 * 9.80 * SLOPE(1)/((100.0 + (RESIS - 100.0) * GRNCO * *
     1 2) * 1.01E - 6))
      TLRIO = (((SLLGT(1)/(AL * SUM * SUM)) * * (1.0/3.0))/60.0)
      WRITE (21) JJJ,ISTOR,ITIME,EXTNE(1),EXTNE(K - 1),TLRIO
      IF (EXNEW(1) .GT. 0.0) GO TO 150
      DO 140 LP140 = 2,J1
         EXTNE(LP140) = EXTNE(LP140) - EXTNE(1)
140   CONTINUE
      EXTNE(1) = 0.0
      GO TO 160
150   WRITE (6,180) NUMDA,(DATE(IMPD1),IMPD1 = 1,5)
160   DO 170 LP170 = 1,MRAIN
         RAIN(LP170) = RAIN(LP170) * 60.0
170   CONTINUE
```

```
      WRITE (14) JJJ,ISTOR,NRAIN,TPRES,(RAIN(IMPD2),RAINT(IMPD2),IMPD2 =
     1 1,NRAIN)
      WRITE (8) JJJ,ISTOR,NUMDA,(DATE(IMPD3),IMPD3 = 1,5),TOTVO,K,(EXNEW
     1(IMPD4),EXTNE(IMPD4),IMPD4 = 1,K),TP,KTP,GRNCO,CANCO
      RETURN
C
C     VARIOUS FORMATS.
C
  180 FORMAT (20X,11HFROM EXCOU.,///20X,17HERROR IN DATA ON ,I4,2X,5A4,1
     19H RAIN(1) IS NOT 0.0,/)
      END
```

SUBROUTINE GEOOU

```
      SUBROUTINE GEOOU
      COMMON /ARAYS/        ARAT(2)      , AT(2)       , CANLO(20)   ,
     1        CANLI(20)   , CASEI(20)   , CCOV(3)     , CCOVT(3)    ,
     2        DATE(5)     , DL(5)       , FC(5)       , FO1(40)     ,
     3        LASTD(12)   , NFIRS(12)   , NR(40)      , PERSZ(11)   ,
     4        POROS(5)    , PSI(5)      , S(5)        , SAVE(5)     ,
     5        SINIT(5)    , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)       , THETA(5)    , TWATC(12)   , VP(5)       ,
     7        WETK(5)     , Z1(5)
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
     D        NSED        , NUMDA       , PAIR        , PER         ,
     E        PERRU       , PI          , PWP         , QI          ,
     F        R1          , R2          , R3          , R4          ,
     G        R5          , RDETC       , RESIS       , RESWA       ,
     H        RLIT        , RN          , RO          , RR1         ,
     I        RRR         , RX          , SEV         , SHIEL       ,
     J        SI          , SIGMA       , SIGRN       , SIMAX
      COMMON /BLOK2/        SIMIN       , SLAT        , STIME       ,
     1        SUN1        , SUN2        , TEMP1       , TEMP2       ,
     2        TOTVO       , TP          , TPRES       , TRCAN       ,
     3        V           , XL          , XN          , Z
      IF (IPLAN .NE. JPLAN) GO TO 100
      WRITE (12,120) JPLAN
  100 WRITE (12,130) POROS(1)
      WRITE (12,130) SLOPE(1),SLLGT(1)
      WRITE (12,130) SLOPE(3),SLLGT(3)
      WRITE (12,130) C1,XN,A1,B1
      WRITE (12,130) RESIS,RDETC,EXPON,FDETC,FDETO,SHIEL,NSED
      DO 110 LP110 = 1,NSED
         WRITE (12,140) SIZE(LP110),PERSZ(LP110)
  110 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  120 FORMAT (I10)
  130 FORMAT (6F10.4,I10)
  140 FORMAT (2E20.5)
      END
```

FUNCTION GROUN (GM, GV, DAYJ, PI)

```
      FUNCTION GROUN (GM,GV,DAYJ,PI)
C
C     P. 132, PHYSICS OF PLANT ENVIRONMENT BY W. R. VAN WIJK.
C
      GROUN = GM + GV * SIN (PI * (DAYJ - 81.0)/182.5)
      RETURN
      END
```

SUBROUTINE HYSNO

```
      SUBROUTINE HYSNO
      COMMON /ARAYS/        ARAT(2)       , AT(2)        , CAWLO(20)    ,
     1        CANLI(20)    , CASEI(20)    , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)        , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)    , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)       , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)     , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)     , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1            , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF        , ALMAX        , ALSR         ,
     2        ALSS         , B1           , C1           , CANCO        ,
     3        CANOF        , CANON        , CPO          , DATEJ        ,
     4        DORAI        , DRUN         , ET           , EXPON        ,
     5        F            , FDETC        , FDETO        , FILT         ,
     6        FLNET        , FO           , G            , GK           ,
     7        GRNCO        , GV           , HT           , IPLAN        ,
     8        ISTOR        , ITIME        , JJJ          , JPLAN        ,
     9        JSTAR        , K            , KJ           , KTP          ,
     A        LLDAY        , MAXDA        , MO           , MOBEG        ,
     B        NALT         , NC           , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN         , NM           , NRAIN        ,
     D        NSED         , NUMDA        , PAIR         , PER          ,
     E        PERRU        , PI           , PWP          , QI           ,
     F        R1           , R2           , R3           , R4           ,
     G        R5           , RDETC        , RESIS        , RESWA        ,
     H        RLIT         , RN           , RO           , RR1          ,
     I        RRR          , RX           , SEV          , SHIEL        ,
     J        SI           , SIGMA        , SIGRN        , SIMAX
      COMMON /BLOK5/        ASPP          , DASYR        , DATIS        ,
     1        DJ930
      COMMON /EMBLK/        CCAL(51)      , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2) , DP(51)        , DPI(51)      , EX(300)      ,
     2        EXNEW(200)   , EXTIM(300)   , EXTNE(200)   , MULTD(366)   ,
     3        PRECI(366)   , RAIN(200)    , RAINT(200)   , RELCO(51,2)  ,
     4        ROLD(200)    , RTOLD(200)   , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)   , SPCH(51)     , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)   , THSOI(51)    , TINC(51)     , TSOIL(51)    ,
     7        VAPOR(366)   , VOL1(5,40)   , WATCO(51,2)
      COMMON /ONLCR/        AVIMC         , BSTMF        , CALDF        ,
     1        COMAX        , CVDEN        , DREDY        , ENWLO        ,
     2        ENGBL        , FREWT        , LSTUS        , NDYSN        ,
     3        ONTRS        , PHASE        , PRWOV        , RCHRG        ,
     4        X(3)         , SMTM3        , TCOEF        , THSHD
      INTEGER               DREDY         , PHASE
      COMMON /WTRBL/        ETFRM         , EVPTR        , GENRO        ,
     1        PRCIP        , RADIN        , RDLWN        , RDSWN        ,
     2        TMPMX        , TMPMN        , WTRIN
      COMMON /VAR99/        SMTM1(3)
C
C     CALCULATE THE DAILY DATA.
C
      PRCIP = PRECI(ITIME)/2.54
      RDHRZ = SOLAR(ITIME)
      TMPMN = TEMPL(ITIME) * 9.0/5.0 + 32.0
      TMPMX = TEMPH(ITIME) * 9.0/5.0 + 32.0
C
C     CALCULATE INCOMING ADJUSTED RADIATION AND POTENTIAL
C     EVAPOTRANSPIRATION.
C
```

```
      CALL RDCMP (DATEJ,DASYR,RDHRZ,RADIN,MD,EVPTR)
C
C     MAKE THE PASS THROUGH THE WATER BALANCE ROUTINES
C
      F9 = SMTM1(1)
      F10 = SMTM1(2)
      F11 = SMTM1(3)
      CALL WATBL (F9,F10,F11)
      SINIT(1) = RCHRG * 2.54/(DL(1) * POROS(1) + DL(2) * POROS(2))
      SMTM1(1) = F9
      SMTM1(2) = F10
      SMTM1(3) = F11
C
C     CHECK THE MANDATORY ISOTHERMAL DATE
C
      IF (DATEJ .NE. DATIS) GO TO 11
C
C     TURN OFF THE DIFFUSION MODEL, SET THE PACK TO 0 C AND ADJUST THE
C     ENERGY BALANCE ACCORDINGLY.
C
      DREDY =  - 1
      ENGBL = ENGBL + CALDF
      RDLWN = RDLWN + CALDF
      CALDF = 0.0
   11 CONTINUE
      RETURN
      END
```

SUBROUTINE IN

```
      SUBROUTINE IN
C
C     THIS ROUTINE INPUTS RAINFALL HYETOGRAPHS FOR EACH STORM DAY.
C
C     PARAMETERS.
C
C        NDAYS = THE NUMBER OF DAYS THE STORM LASTS.
C
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , B1          , C1           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DDRAI        , DRUN        , ET           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GM           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , MAXDA       , MD           , MOBEG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RR1          ,
     I        RRR          , RX          , SEV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
```


Reproduced from best available copy.

```
      COMMON /EMBLK/          CCAL(51)     , CMAT(51)     , CUMEX(300)  ,
     1        DEGSA(51,2) , DP(51)       , DPI(51)      , EX(300)     ,
     2        EXNEW(200)  , EXTIM(300)   , EXTNE(200)   , MULTD(366)  ,
     3        PRECI(366)  , RAIN(200)    , RAINT(200)   , RELCO(51,2) ,
     4        ROLD(200)   , RTOLD(200)   , SLCON(51,2)  , SLPOT(51,2) ,
     5        SOLAR(366)  , SPCH(51)     , TEMP(366)    , TEMPH(366)  ,
     6        TEMPL(366)  , THSOI(51)    , TINC(51)     , TSOIL(51)   ,
     7        VAPOR(366)  , VOL1(5,40)   , WATCO(51,2)
      DIMENSION             DDATE(5)
C
C     INITIALIZE VARIABLES.
C
      TIME = 0.0
      NRAIN = 0
      IBEG = 1
      DO 130 LP130 = 1,NDAYS
         READ (33,150) (DDATE(IMPD1),IMPD1 = 1,5)
         IF (LP130 .NE. 1) GO TO 110
         DO 100 LP100 = 1,5
            DATE(LP100) = DDATE(LP100)
  100    CONTINUE
         WRITE (61,160) (DATE(IMPD2),IMPD2 = 1,5),NDAYS
  110    READ (33,170) NNUMD
         IF (LP130 .EQ. 1) NUMDA = NNUMD
         READ (33,180) ADJTI
         READ (33,170) IRAIN
         NR(LP130) = IRAIN
         NRAIN = NRAIN + IRAIN
         DO 120 LP120 = IBEG,NRAIN
            READ (33,180) RAIN(LP120),RAINT(LP120)
            RAINT(LP120) = RAINT(LP120) + TIME
  120    CONTINUE
         IBEG = IBEG + IRAIN
         TIME = RAINT(NRAIN)
  130 CONTINUE
C
C     THE RAINFALL INTENSITIES ARE CONVERTED TO CENTIMETERS PER MINUTE
C     FOR USE BY THE INTERCEPTION AND INFILTRATION ROUTINES.
C
      DO 140 LP140 = 1,NRAIN
         RAIN(LP140) = RAIN(LP140) * 2.54/60.0
  140 CONTINUE
      WRITE (61,190) (RAIN(IMPD3),RAINT(IMPD3),IMPD3 = 1,NRAIN)
      RETURN
C
C     VARIOUS FORMATS.
C
  150 FORMAT (5A4)
  160 FORMAT (/20X,5A4,40H IS THE FIRST DAY OF A STORM THAT LASTS ,I3,6H
     1 DAYS.,/)
  170 FORMAT (I3)
  180 FORMAT (2F10.5)
  190 FORMAT (20X,7HFROM IN,/,20X,17HINTENSITY(CM/MIN),13X,9HTIME(MIN),/
     1((20X,F15.7,9X,F15.2)))
      END
```

```
      SUBROUTINE INTRC
C
C     PARMETERS IN THE ARGUMENT LIST:
C
C        NDAYS = NUMBER OF DAYS THE STORM LASTS.
C
      COMMON /ARAYS/        ARAI(2)       , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)    , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)        , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)    , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)       , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)     , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)     , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1            , ADJTI        , ALBGK        ,
     1        ALBVE        , ALEAF        , ALMAX        , ALSR         ,
     2        ALSS         , B1           , C1           , CANCO        ,
     3        CANOF        , CANON        , CPO          , DATEJ        ,
     4        DDRAI        , DRUN         , ET           , EXPON        ,
     5        F            , FDETC        , FDETO        , FILT         ,
     6        FLNET        , FO           , G            , GM           ,
     7        GRNCO        , GV           , HT           , IPLAN        ,
     8        ISTOR        , ITIME        , JJJ          , JPLAN        ,
     9        JSTAR        , K            , KJ           , KTP          ,
     A        LLDAY        , MAXDA        , MO           , MOBEG        ,
     B        NALT         , NC           , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN         , NM           , NRAIN        ,
     D        NSED         , NUMDA        , PAIR         , PER          ,
     E        PERRU        , PI           , PWP          , QI           ,
     F        R1           , R2           , R3           , R4           ,
     G        R5           , RDETC        , RESIS        , RESWA        ,
     H        RLIT         , RN           , RO           , RR1          ,
     I        RRR          , RX           , SEV          , SHIEL        ,
     J        SI           , SIGMA        , SIGRN        , SIMAX
      COMMON /BLOK2/        SIMIN         , SLAT         , STIME        ,
     1        SUN1         , SUN2         , TEMP1        , TEMP2        ,
     2        TOTVO        , TP           , TPRES        , TRCAN        ,
     3        V            , XL           , XN           , Z
      COMMON /EMBLK/        CCAL(51)      , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2)  , DP(51)       , DPI(51)      , EX(300)      ,
     2        EXNEW(200)   , EXTIM(300)   , EXTNE(200)   , MULTD(366)   ,
     3        PRECI(366)   , RAIN(200)    , RAINT(200)   , RELCO(51,2)  ,
     4        ROLD(200)    , RTOLD(200)   , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)   , SPCH(51)     , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)   , THSOI(51)    , TINC(51)     , TSOIH(51)    ,
     7        VAPOR(366)   , VOL1(5,40)   , WATCO(51,2)
      DIMENSION             EVPLS(40)     , WMAXO(40)
C
C     INITIALIZE.
C
      SII = SI
      KINTR = 0
C
C     SAVE THE RAINSTORM AS 'ROLD'.  THE THROUGHFALL WILL BECOME ARRAY
C     'RAIN'.
C
      DO 100 LP100 = 1,NRAIN
         ROLD(LP100) = RAIN(LP100)
         RTOLD(LP100) = RAINT(LP100)
  100 CONTINUE
      IFRON = 0
C
C     DETERMINE DAILY 'FRONT-END' OR EVAPORATION LOSS FOR EACH OF
C     'NDAYS' DAYS.
C
```

```
      DO 170 LP170 = 1,NDAYS
         IND = ITIME + LP170 - 1
         T = DATEJ + FLOAT (LP170 - 1)
C
C     INTERCEPTION VOLUME CHANGES WITH CANOPY SIZE. THE PROGRAM UNIT
C     'CANOP' CALCULATES THE CANOPY LEAF AREA FOR DAY 'IND'.  'STORE'
C     IS THE MAXIMUM AMOUNT OF INTERCEPTION STORAGE AVAILABLE ON DAY
C     'IND'.
C
         CALL CANOP (T,AL,CAN)
         STORE = (1.0 - CAN) * GRNCO * SIGRN + CAN * (SIMIN + (AL/ALMAX)
     1    * (SIMAX - SIMIN))
         WMAX = STORE - SII
C
C     COMPARE THE PRESENT DAY'S TOTAL PRECIPITATION AND THE PRESENT
C     DAY'S 'FRONT-END' POTENTIAL INTERCEPTION VOLUME.
C
         IF (PRECI(IND) .GT. WMAX) GO TO 120
C
C     IF THE PRECIPITATION IS INSUFFICIENT TO FILL THIS DAY'S 'FRONT-
C     END' REQUIREMENT, ADD THE PRECIPITATION TO THE EXISTING INTERCEP-
C     TION STORAGE VOLUME AND ADD ONE TO THE NUMBER OF DAYS AT THE
C     BEGINNING OF THE RAINFALL WITH NO THROUGHFALL.
C
         SII = SII + PRECI(IND)
         IF (IFRON .GE. 1) GO TO 110
C
C     'WMAXO' IS AN ARRAY CONTAINING 'FRONT-END' INTERCEPTION FOR EACH
C     DAY.  'EVPLS' CONTAINS EVAPORATION LOSSES FOR DAYS AFTER THE
C     'FRONT-END' INTERCEPTION HAS BEEN SATISFIED.
C
         WMAXO(LP170) = PRECI(IND)
         EVPLS(LP170) = 0.0
         GO TO 140
  110    EVPLS(LP170) = PRECI(IND)
         WMAXO(LP170) = 0.0
         GO TO 140
  120    SII = STORE
         IF (IFRON .GE. 1) GO TO 130
         WMAXO(LP170) = WMAX
         EVPLS(LP170) = 0.0
         IFRON = 1
         GO TO 140
  130    EVPLS(LP170) = WMAX
         WMAXO(LP170) = 0.0
C
C     THIS SECTION CALCULATES THE DAILY POTENTIAL EVAPORATION LOSS FROM
C     INTERCEPTION, 'ETINT'. 'RN' IS THE NET ABSORBED SOLAR RADIATION
C     AVAILABLE ON THE DAY INDEXED BY 'IND'. 'G' IS THE DAILY FLUX OF
C     ENERGY FROM THE GROUND TO THE CANOPY, AND 'TPRES' IS THE PRESENT
C     TEMPERATURE OF DAY 'IND'.  EVAP IS THE PROGRAM UNIT THAT CALCU-
C     LATES THE POTENTIAL EVAPORATION FROM THE INTERCEPTION VOLUME.
C
  140    RNINT = SOLAR(IND) * (1.0 - ALBVE)
         GINTR = GROUN (GM,GV,T,PI)
         TINTR = TEMP(IND)
         RX = 0.0
         IVAP = 0
         CALL EVAP (RNINT,GINTR,TINTR,ETINT,IVAP)
C
C     COMPARE EVAPORATION POTENTIAL TO THE VOLUME OF WATER CURRENTLY
C     IN STORAGE.
C
         IF (ETINT .GE. SII) GO TO 150
C
C     IF THE POTENTIAL EVAPORATION IS LESS THAN THE VOLUME OF WATER IN
C     INTERCEPTION STORAGE, DEDUCT THE EVAPORATED WATER FROM THE INTER-
C     CEPTION VOLUME TO FORM THE NEW VOLUME OF WATER IN INTERCEPTION
C     STORAGE.
C
         SII = SII - ETINT
         GO TO 160
```

```
C
C     IF THE POTENTIAL EVAPORATION IS GREATER THAN THE VOLUME IN INTER-
C     CEPTION STORAGE, THEN ALL INTERCEPTED WATER IS EVAPORATED AND
C     THE STORAGE IS SET EQUAL TO ZERO.
C
  150    SII = 0.0
C
C     'WMAX' IS THE UNFILLED PORTION OF 'STORE' TO BE DEDUCTED FROM THE
C     NEXT DAY'S RAINFALL AS 'FRONT-END' INTERCEPTION IF 'IFRON = 0',
C     OR UNIFORMLY REMOVED FROM THE STORM IF 'IFRON = 1'.
C
C     TURN OFF THE 'FRONT-END' INTERCEPTION MODE BY SETTING IFRON = 1.
C
  160    IF (PRECI(IND) .GT. WMAX) IFRON = 1
  170 CONTINUE
C
C     THIS SECTION ACTUALLY MODIFIES THE RAINFALL HYETOGRAPH FOR NDAYS
C     RAIN AND CREATES A THROUGHFALL HISTOGRAM FOR INPUT TO THE INFIL-
C     TRATION ROUTINE.  THE THROUGHFALL HISTOGRAM COMBINES THE NDAYS
C     RAINFALL INTO ONE CONTINUOUS EVENT.
C
      N3 = 1
      N5 = NR(1)
C
C     IF THERE ARE NO COMPLETE DAYS WHEN THE 'FRONT-END' INTERCEPTION
C     WAS NOT MET, PROCEED DIRECTLY TO THE 'FRONT-END' MODIFICATION
C     SECTION.
C
      DO 260 LP260 = 1,NDAYS
         IF (WMAXO(LP260) .LE. 0.0) GO TO 210
         VINTR = WMAXO(LP260)
         VRAI = 0.0
C
C     THIS SECTION MODIFIES THE STORM ON THE DAY THAT 'FRONT-END'
C     STORAGE IS FIRST EXCEEDED BY RAINFALL.
C
         DO 180 LP180 = N3,N5
            KINTR = LP180
            VRAI = VRAI + ROLD(LP180) * RTOLD(LP180)
            IF (LP180 .GT. 1) VRAI = VRAI - ROLD(LP180) * RTOLD(LP180 -
     1      1)
            IF (VRAI .GT. VINTR) GO TO 190
            RAIN(LP180) = 0.0
  180    CONTINUE
         WRITE (6,270)
         CALL EXIT
  190    DRV = VRAI - VINTR
         DRVD = RTOLD(KINTR)
         IF (KINTR .GT. 1) DRVD = DRVD - RTOLD(KINTR - 1)
         RAIN(KINTR) = DRV/DRVD
         KINTR = KINTR + 1
         DO 200 LP200 = KINTR,N5
         RAIN(LP200) = ROLD(LP200)
  200    CONTINUE
         GO TO 250
C
C     THIS SECTION MODIFIES THE REMAINING DAYS OF THE STORM FOR DAILY
C     EVAPORATION LOSSES.
C
  210    DTIME = 0.0
         DO 220 LP220 = N3,N5
            DTI = RTOLD(LP220) - RTOLD(LP220 - 1)
            IF (ROLD(LP220) .GT. 0.0) DTIME = DTIME + DTI
  220    CONTINUE
         CHGIN = EVPLS(LP260)/DTIME
  230    VSHOR = 0.0
         DO 240 LP240 = N3,N5
            IF (RAIN(LP240) .LE. 0.0) GO TO 240
            RAIN(LP240) = RAIN(LP240) - CHGIN
            IF (RAIN(LP240) .GT. 0.0) GO TO 240
            VSHOR = ABS (RAIN(LP240)) + VSHOR
```

```
      RAIN(LP240) = 0.0
      DTIME = DTIME - RTOLD(LP240)
      IF (LP240 .GT. 1) DTIME = DTIME + RTOLD(LP240 - 1)
240   CONTINUE
      CHGIN = VSHOR/DTIME
      IF (VSHOR .GT. 0.0) GO TO 230
250   IF (LP260 .EQ. NDAYS) GO TO 260
      N3 = N3 + NR(LP260)
      N5 = N5 + NR(LP260 + 1)
260 CONTINUE
    RETURN
C
C   VARIOUS FORMATS.
C
270 FORMAT (20X,26H***********ERROR IN INTRC*)
    END
```

SUBROUTINE LAYIN

```
      SUBROUTINE LAYIN
      COMMON /ARAYS/        ARAT(2)      , A1(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , B1          , C1           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DDRAI        , DRUN        , E1           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GK           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , MAXDA       , MO           , MOBEG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RK1          ,
     I        RRR          , RX          , SEV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
      COMMON /BLOK2/        SIMIN        , SLAT         , STIME        ,
     1        SUN1         , SUN2        , TEMP1        , TEMP2        ,
     2        TOTVO        , TP          , TPRES        , TRCAN        ,
     3        V            , XL          , XN           , Z
      COMMON /EMBLK/        CCAL(51)     , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2)  , DP(51)      , DPI(51)      , EX(300)      ,
     2        EXNEW(200)   , EXTIM(300)  , EXTME(200)   , MULTD(366)   ,
     3        PRECI(366)   , RAIN(200)   , RAINT(200)   , RELCO(51,2)  ,
     4        ROLD(200)    , RTOLD(200)  , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)   , SPCH(51)    , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)   , THSOI(51)   , TINC(51)     , TSOIL(51)    ,
     7        VAPOR(366)   , VOL1(5,40)  , WATCO(51,2)
```

```
C
C     INITIALIZATIONS.
C
      WRITE (61,300) (SINIT(IMPD1),WETK(IMPD1),POROS(IMPD1),SAVE(IMPD1),
     1DL(IMPD1),IMPD1 = 1,5)
      M = 1
      LDAY = 1
      FO = 0.0
      II = NR(LDAY)
      T = 0.0
      N = 0
      ZLYIN = 0.0
      THLAY = POROS(M) * (SW(M) - SINIT(M))
      WK = 0.0
      FK = 0.0
      IT = 0
      C = THLAY * SAVE(M)
      D = 0.0
C
C     MAIN INFILTRATION LOOP.
C
      DO 220 LP220 = 1,NRAIN
         FL = 0.0
         K = LP220
         MOLD = M
         FOOLD = FO
         ZOLD = ZLYIN
         DTM = RAIND (T)
         DT = DTM
         T = T + DTM
         R = RAINI (T)
         IF (R .LE. 0.0) GO TO 130
C
C     DETERMINE THE CHANGE IN FO DURING TIME INCREMENT DTM FOR THE
C     M-TH LAYER OF A LAYERED SOIL.
C
  100    Q = WETK(M) * (2.0 * D - DTM) + 2.0 * FO
         RDF =  - 2.0 * WETK(M) * DTM * (C + FO)
         DELF =  - 0.5 * Q + 0.5 * SQRT (Q * Q - 4.0 * RDF)
C
C     COMPUTE POTENTIAL INCREASE IN INFILTRATED VOLUME.
C
         POTZ = ZLYIN + (DELF/(POROS(M) * (SW(M) - SINIT(M))))
C
C     IS POTENTIAL VOLUME GREATER THAN THE CURRENT LAYER DEPTH?
C
         IF (POTZ .LT. Z1(M)) GO TO 110
         IF (M .GE. 5) WRITE (6,310)
         IF (M .GE. 5) CALL EXIT
C
C     PULL IN DATA FOR NEW LAYER.
C
         IT = 1
         DELF = (Z1(M) - ZLYIN) * POROS(M) * (SW(M) - SINIT(M))
         FL = FL + DELF
C
C     DETERMINE THE TIME INCREMENT REQUIRED TO INFILTRATE A VOLUME
C     OF WATER DELF AT THE POTENTIAL RATE USING EXPLICIT GREEN-AMPT
C     FORMULATION. THIS IS USED FOR LAYERED SOILS.
C
         B = (2.0 * DELF)/(2.0 * (C + FO) + DELF)
         DTM = DTM - ((D - C/WETK(M)) * B + DELF/WETK(M))
         FO = FO + DELF
         ZLYIN = Z1(M)
         FK = FK + THLAY * DL(M)
         M = M + 1
```

```
      THLAY = POROS(M) * (SW(M) - SINIT(M))
      WK = WK + (DL(M - 1)/(WETK(M - 1)))
      C = THLAY * (Z1(M - 1) + SAVE(M)) - FK
      D = WK * THLAY - FK/WETK(M)
      GO TO 100
C
C     IN CORRECT LAYER.
C
  110 IF (IT .EQ. 1) DELF = DELF + FL
      FD = DELF/DT
C
C     COMPARE RAINFALL AND INFILTRATION RATES.
C
      IF (FD .GT. R) GO TO 130
C
C     POTENTIAL RATE CONTROL.
C
      IF (N .NE. 0) GO TO 120
      N = 1
C
C     TIME OF FIRST PONDING.
C
      KTP = K
      TP = T - DT
  120 EX(K) = R - FD
      EXTIM(K) = T
      ZLYIN = POTZ
      FO = FOOLD + DELF
      IF (IT .EQ. 1) IT = 0
      GO TO 180
C
C     RAINFALL CONTROL WITH LAYER CHANGE DURING DT.
C
  130 EX(K) = 0.0
      EXTIM(K) = T
      F1 = R * DT
      FO = FOOLD + F1
      ZLYIN = ZOLD
C
C     RAINFALL CONTROL WITH NO LAYER CHANGE DURING DT.
C
      IF (IT .NE. 1) ZLYIN = ZLYIN + F1/THLAY
      IF (IT .NE. 1) GO TO 180
      F2 = 0.0
C
C     UPDATE INFILTRATED DEPTH FOR RAINFALL CONTROL WITH LAYER CHANGE.
C
      DO 140 LP140 = MOLD,5
         KK140 = LP140
         THLAY = POROS(LP140) * (SW(LP140) - SINIT(LP140))
         F2OLD = F2
         F2 = (Z1(LP140) - ZLYIN) * THLAY + F2
         IF (F2 .GE. F1) GO TO 150
         ZLYIN = Z1(LP140)
  140 CONTINUE
  150 IT = 0
      ZLYIN = ZLYIN + (F1 - F2OLD)/THLAY
      IF (M .EQ. KK140) GO TO 180
      FK = 0.0
      WK = 0.0
      IF (KK140 .EQ. 1) GO TO 170
      M1 = KK140 - 1
      DO 160 LP160 = 1,M1
         THLAY = POROS(LP160) * (SW(LP160) - SINIT(LP160))
         FK = FK + THLAY * DL(LP160)
         WK = WK + DL(LP160)/WETK(LP160)
  160 CONTINUE
  170 M = KK140
      THLAY = POROS(M) * (SW(M) - SINIT(M))
      C = SAVE(M) * THLAY - FK
      IF (M .GT. 1) C = C + Z1(M - 1) * THLAY
```

```
      D = WK * THLAY + FK/WETK(M)
180   IF (LP220 .LT. II) GO TO 220
      FO1(LDAY) = FO
      IF (M .EQ. 1) GO TO 200
      M2 = M - 1
      DO 190 LP190 = 1,M2
         VOL1(LP190,LDAY) = POROS(LP190) * (SW(LP190) - SINIT(LP190))
     1      * DL(LP190)
190   CONTINUE
      ZC = Z1(M - 1)
      GO TO 210
200   ZC = 0.0
210   VOL1(M,LDAY) = POROS(M) * (SW(M) - SINIT(M)) * (ZLYIN - ZC)
      LDAY = LDAY + 1
      IF (LP220 .EQ. NRAIN) GO TO 220
      II = II + NR(LDAY)
220 CONTINUE
C
C     SUPPRESS TRAILING ZEROS IN EXCESS ARRAY.
C
      DO 230 LP230 = 1,K
         KK230 = K - LP230 + 1
         IF (EX(KK230) .NE. 0.0) GO TO 240
230 CONTINUE
    TOTVO = 0.0
    GO TO 260
240 CUMEX(1) = 0.0
    DO 250 LP250 = 2,KK230
       DTM = EXTIM(LP250) - EXTIM(LP250 - 1)
       CUMEX(LP250) = CUMEX(LP250 - 1) + EX(LP250) * DTM
250 CONTINUE
    K = KK230 + 1
    CUMEX(K) = CUMEX(K - 1)
    EX(K) = 0.0
    EXTIM(K) = EXTIM(K - 1) + 1.E38
    WRITE (61,320) (EX(IMPD2),EXTIM(IMPD2),CUMEX(IMPD2),IMPD2 = 1,K)
    TOTVO = CUMEX(K)
C
C     PREPARE INFILTRATION RESULTS FOR RETURN TO PROSP.
C
260 IF (LDAY .LE. 2) GO TO 290
    LDAY1 = LDAY - 1
    DO 280 LP280 = 2,LDAY1
       KK280 = LDAY - LP280 + 1
       FO1(KK280) = FO1(KK280) - FO1(KK280 - 1)
       DO 270 LP270 = 1,5
          VOL1(LP270,KK280) = VOL1(LP270,KK280) - VOL1(LP270,KK280 - 1
     1    )
270    CONTINUE
280 CONTINUE
290 CONTINUE
    RETURN
C
C     VARIOUS FORMATS.
C
300 FORMAT (/39X,5HSINIT,10X,4HWETK,9X,5HPOROS,10X,4HSAVE,12X,2HDL/(30
   1X,5(2X,F12.5)))
310 FORMAT (/20X,53HMORE SOIL LAYER DEPTH IS NEEDED.  MESSAGE FROM LAY
   1IN.)
320 FORMAT (/47X,2HEX,8X,6HEXTIME,9X,5HCUMEX,/(35X,3(2X,G12.5)))
    END
```

SUBROUTINE LINK (CLAIR, CALRE, IRTRN)

```
      SUBROUTINE LINK (CLAIR,CALRE,IRTRN)
C
C     THIS PROGRAM UNIT IS THE INTERFACE BETWEEN THE RADIATION BALANCE
C     (PROGRAM UNIT RADBL) AND THE DIFFUSION MODEL (PROGRAM UNIT DIFMD)
C
C     DICTIONARY
C
C     CALDM - THE CALORIC LOSS OF GAIN AS COMPUTED BY THE DIFFUSION
C                 MODEL
C
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWOV       , RCHRG       ,
     4        SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER               DREDY       , PHASE
      COMMON /WTRBL/        ETFRM       , EVPTR       , GFNRO       ,
     1        PRCIP       , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX       , TMPMN       , WTRIN
C
C     SEE IF THE RADIATION BALANCE IS AN ENERGY LOSS OR GAIN
C
      IF (CALRE) 100,100,170
C
C     THERE WAS A LOSS.  IF THIS IS STILL WINTER (NO FREE WATER), JUST
C      GO AHEAD AND USE THE DIFFUSION MODEL
C
  100 IF (FREWT) 110,110,140
C
C     USE THE DIFFUSION MODEL TO SIMULATE THE CURRENT AVERAGE SNOWPACK
C     TEMPERATURE
C
  110 IF (DREDY.NE.1) GO TO 230
      CALL DIFMD
      IF (DREDY) 130,130,120
C
C     NOW MAKE ANY NECESSARY ADJUSTMENTS IN THE RADIATION BALANCE TO
C      CAUSE THE PACK TEMPERATURE TO BE THE SAME AS - SMTM3 -. GET THE
C      DIFFERENCE BETWEEN THE CALORIE DEFICITS AS COMPUTED BY THE
C      DIFFERENT METHODS
C
  120 CALDM = CALDF + (SMTM3 * PRWOV * 1.27)
C
C     ADJUST THE LONG WAVE PORTION OF THE RADIATION BALANCE BY THE
C      DIFFERENCE BETWEEN THE CALORIES DERIVED FROM THE DIFFUSION MODEL
C      AND THE ENERGY BALANCE
C
      CALRE = CALDM
      RDLWN = CALRE - RDSWN
  130 IRTRN = 0
      RETURN
C
C     THE LOSS IS USED TO FREEZE PART OR ALL OF THE FREE WATER, BUT IT
C      MAY NOT CREATE COLD CONTENT.  IF IT WOULD CREATE COLD CONTENT,
C      RE-INITIALIZE THE DIFFUSION MODEL TO 0 AND ADJUST THE ENERGY
C      BALANCE ACCORDINGLY
C
  140 CALL CALOS (CALRE)
      IF (FREWT - 0.05) 150,150,160
  150 SMTM1(1) = AMIN1(AVTMC,0.0)
      SMTM1(2) = 0.0
      SMTM1(3) = 0.0
      DREDY = 1
C
C     MAKE ANY NECESSARY ADJUSTMENTS TO THE ENERGY BALANCE TO COMPENSATE
C      FOR THE COLD CONTENT THAT WOULD HAVE BEEN GENERATED BY THIS LOSS
C      AND ZERO THE COLD CONTENT
C
```

```
      ENGBL = ENGBL + CALDF
      RDLWN = RDLWN + CALDF
      FREWT = 0.0
      CALDF = 0.0
  160 IRTRN = 1
      RETURN
C
C     THERE IS CALORIC INPUT TO THE PACK.  CHECK TO SEE IF CONDITIONS
C      INDICATE THAT THE DIFFUSION MODEL SHOULD BE TURNED OFF AND THE
C      ENERGY BALANCE USED FOR SPRINGTIME SIMULATION.  CONSIDER FIRST
C      ANY COLD CONTENT (INCLUDING THAT OF THE PREVIOUS DAY AND ANY
C      CREATED BY A SNOW EVENT ON THIS DAY).  IF THERE IS COLD CONTENT,
C      CHECK THE AVERAGE AIR TEMPERATURE AND THE SNOWPACK TEMPERATURE
C      FROM THE PREVIOUS DAY FOR ARBITRARILY CHOSEN SPRINGTIME
C      CONDITIONS AND IF ALL ARE NOT SATISFIED, GO AHEAD AND USE THE
C      DIFFUSION MODEL
C
  170 IF (CALDF) 260,260,180
C
C     0.889 = 1.27 * 0.7 DEGREES C (ARBITRARY TEMP)
C
  180 IF ((AVTMC.LE.0.0).OR.(CALDF.GT.(PRWQV * 0.889))) GO TO 110
C
C     SINCE SPRINGTIME CONDITIONS PREVAIL, RECOMPUTE THE BACK RADIATION
C      AND THE NET RADIATION BALANCE (REMEMBER, IF THERE IS SNOW, THE
C      LONGWAVE IS ASSUMED TO BE ZERO, SO THERE WOULD BE NO NEED TO MAKE
C      ANY ADJUSTMENTS)
C
      IF (NDYSN) 230,230,190
  190 USE = (TMPMN - 32.0) * 5.0/9.0
      IF (USE.GT.0.0) USE = 0.0
      CLSNW = 1.17E - 7 * ((USE + 273.16) *  * 4)
      IF (PRCIP) 200,200,210
  200 RDLWN = ((1.0 - CVDEN) * ((0.757 * CLAIR) - CLSNW)) + (CVDEN * (CL
     1AIR - CLSNW))
      GO TO 220
  210 RDLWN = CLAIR - CLSNW
  220 CALRE = RDSWN + RDLWN
C
C     RE-INITIALIZE THE DIFFUSION MODEL TO THESE CONDITIONS (BUT IF THE
C      INPUT IS MORE THAN ENOUGH TO WIPE OUT THE CALORIE DEFICIT, JUST
C      LET IT BRING THE PACK TO ISOTHERMAL.  IN THIS WAY, TWO CONSECU-
C      TIVE DAYS OF INPUT ARE REQUIRED TO GENERATE FREE WATER)
C
  230 CMPAR = CALRE - CALDF
      IF (CMPAR) 250,240,240
C
C     INITIALIZE THE DIFFUSION MODEL TO ISOTHERMAL CONDITIONS
C
  240 SMTM1(1) = 0.0
      SMTM1(2) = 0.0
      SMTM1(3) = 0.0
      SMTM3 = 0.0
      DREDY = 1
      GO TO 120
C
C     REDEFINE THE SURFACE TEMPERATURE AND COMPUTE THE NEW AVERAGE PACK
C      TEMPERATURE.  THEN COMPUTE THE MIDDLE NODE AS A FUNCTION OF THAT
C      AVERAGE, THE SURFACE TEMPERATURE AND THE GROUND TEMPERATURE
C      (WHICH REMAINED UNCHANGED)
C
  250 SMTM1(1) = AMIN1(0.0,AVTMC)
      SMTM3 = CMPAR/(PRWQV * 1.27)
      SMTM1(2) = (3.0 * SMTM3) - SMTM1(1) - SMTM1(3)
      SMTM1(3) = 0.0
      DREDY = 1
      GO TO 120
C
C     THERE IS INPUT TO THE PACK AND THE PACK IS ALREADY ISOTHERMAL.  IF
C      THIS ENERGY WILL CREATE AT LEAST 0.05 INCH (ARBITRARY AMOUNT) OF
C      FREE WATER, SET THE DIFFUSION MODEL TO STANDBY STATUS AND LET THE
C      ENERGY BALANCE TAKE ITS COURSE
C
  260 IF (FREWT + (CALRE/203.2) - 0.05) 240,270,270
  270 DREDY = 0
      IRTRN = 0
C
C     THIS HAS BEEN ADDED TO CORRECT THE STANDBY STATUS FUNCTIONING
C
      PHASE =  - 1
      RETURN
      END
```

SUBROUTINE MOIOU

```
      SUBROUTINE MOIOU
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      WRITE (17,100) SINIT (1)
      RETURN
C
C     VARIOUS FORMATS.
C
  100 FORMAT (F10.4)
      END
```

SUBROUTINE MXTRE

```
      SUBROUTINE MXTRE
C
C     THIS PROGRAM UNIT CONTROLS THE COMPUTATIONS FOR A PRECIPITATION
C      EVENT THAT IS A MXTRE OF SNOW AND RAIN
C
      COMMON /ONLCR/        AVTMC        , BSTMF        , CALDF        ,
     1        CDMAX        , CVDEN       , DREDY        , ENGBL        ,
     2        ENBL1        , FREWT       , LSTUS        , NDYSN        ,
     3        ONTRS        , PHASE       , PRWOV        , RCHRG        ,
     4        SMTM1(3)     , SMTM3       , TCOEF        , THSHD
      INTEGER               DREDY        , PHASE
      COMMON /WTRBL/        ETFRM        , EVPTR        , GENRO        ,
     1        PRCIP        , RADIN       , RDLWN        , RDSWN        ,
     2        TMPMX        , TMPMN       , WTRIN
C
C     DICTIONARY
C
C     AMTRN - THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN
C     TFORN - THE TEMPERATURE FOR COMPUTING THE DEPLETION OF THE TOTAL
C                 CALORIE DEFICIT CAUSED BY THE RAIN (DEGREES C)
C     TFOSN - THE TEMPERATURE FOR COMPUTING THE CONTRIBUTION OF THE
C                 SNOW TO THE TOTAL CALORIE DEFICIT (DEGREES C)
C
C     COMPUTE THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN
C      AMOUNT RAIN = P * (B/A), WHERE
C      P = PRECIPITATION IN INCHES
C      B = DAILY MAXIMUM TEMPERATURE - BASE TEMPERATURE (DEGREES F)
C      A = DAILY MAXIMUM TEMPERATURE - MINIMUM TEMPERATURE (DEGREES F)
C
      B = TMPMX - BSTMF
      A = TMPMX - TMPMN
      AMTRN = PRCIP * (B/A)
C
C     NOW COMPUTE THE AVERAGE TEMPERATURES (DEGREES C) WHICH PRODUCE
C      SNOW AND RAIN
C
      TFOSN = (TMPMN + BSTMF - 64.0) * 5.0/18.0
      TFORN = (TMPMX + BSTMF - 64.0) * 5.0/18.0
C
C     COMPUTE THE EFFECT OF THE SNOW ON THE SNOWPACK
C
      ABCDE = PRCIP - AMTRN
      CALL SNOWD (TFOSN,ABCDE)
C
C     COMPUTE THE EFFECT OF THAT PORTION OF THE PRECIPITATION OCCURRING
C      AS RAIN ON THE SNOWPACK
C
      CALL RASNO (TFORN,AMTRN)
      RETURN
      END
```

SUBROUTINE NGEOU

```
      SUBROUTINE NGEOU
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FDI(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , B1          , C1           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DDRAI        , DRUN        , FT           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GM           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , MAXDA       , MO           , MOBEG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RR1          ,
     I        RRR          , RX          , SEV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
      RIO = FLOAT (ITIME)
      WRITE (16) SLLGT(1),SLLGT(3),SLOPE(1),POROS(1),SW(1),FC(1),RIO
      RETURN
      END
```

SUBROUTINE PARAM

```
      SUBROUTINE PARAM
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FDI(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , B1          , C1           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DDRAI        , DRUN        , FT           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GM           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , MAXDA       , MO           , MOBEG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RR1          ,
     I        RRR          , RX          , SEV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
```

```
      COMMON /BLOK2/        SIMIN       , SLAT        , STIME       ,
     1        SUN1        , SUN2        , TEMP1       , TEMP2       ,
     2        TOTVO       , TP          , TPRES       , TRCAN       ,
     3        V           , XL          , XN          , Z
      COMMON /BLOK5/        ASPP        , DASYR       , DATIS       ,
     1        DJ930
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , ENBLO       ,
     2        ENGBL       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWQV       , RCHRG       ,
     4        X(3)        , SMTM3       , TCOEF       , THSHD
      INTEGER               DREDY       , PHASE
      COMMON /VAR99/        SMTM1(3)
C
C     CASEI IS AN ALPHANUMERIC PROBLEM DESCRIPTION.  IT WILL BE THE
C     OUTPUT HEADING AND WILL BE OUTPUT ONE TIME BY THIS PROGRAM.  IT
C     SHOULD BE USED TO DESCRIBE THE TOTAL PROBLEM.  THE CASEI IN THE
C     PROGRAM UNIT ENDAT SHOULD BE USED TO DESCRIBE EACH SPECIFIC CASE.
C
      READ (2,140) CASEI
      WRITE (61,150) CASEI
C
C     IF LLDAY IS 0, DAILY VALUES WILL NOT BE WRITTEN.
C
      READ (2,160) LLDAY,ALSR,ALSS
      IF (LLDAY .EQ. 0) WRITE (61,170)
      READ (2,180) (DL(IMPD1),IMPD1 = 1,5)
      READ (52,180) (THETA(IMPD2),IMPD2 = 1,5)
      READ (2,180) (FC(IMPD3),IMPD3 = 1,5)
      WRITE (61,190) DL,THETA,FC
      READ (2,180) PAIR,CPO,XL,V
      WRITE (61,200) PAIR,CPO,XL,V
      READ (2,180) AT,ARAT,GM,GV
      WRITE (61,210) AT,ARAT,GM,GV
      READ (51,220) NCAN,NCAN1
      READ (51,230) (CANLI(IMPD4),IMPD4 = 1,NCAN)
      READ (51,230) (CANLO(IMPD5),IMPD5 = 1,NCAN)
      READ (51,180) ALBVE,CANON,CANOF,SIMIN,SIMAX
      ALMAX = CANLI(1)
      ALMIN = CANLI(1)
      IF (NCAN .EQ. 1) GO TO 110
      DO 100 LP100 = 2,NCAN
         IF (CANLI(LP100) .GT. CANLI(LP100 - 1)) ALMAX = CANLI(LP100)
         IF (CANLI(LP100) .LT. CANLI(LP100 - 1)) ALMIN = CANLI(LP100)
  100 CONTINUE
  110 IF (NCAN1 .EQ. 1) GO TO 120
      READ (51,230) CCOV(1),CCOV(2),CCOVT(1),CCOVT(2)
      CCOV(3) = CCOV(2)
      CCOVT(3) = 370.0
      GO TO 130
  120 CCOVT(1) = 370.0
      READ (51,230) CCOV(1)
  130 WRITE (61,240) ALBVE,CANON,CANOF,SIMIN,SIMAX,ALMIN,ALMAX
      READ (2,230) (SW(IMPD6),IMPD6 = 1,5)
      READ (2,230)  ALBGR,TRCAN,SIGRN
      TCOEF = TRCAN
      READ (51,230) GRNCO
      READ (2,230) SLLGT(1),SLOPE(1),ASPP
      WRITE (61,250) GRNCO,SLLGT(1),SLOPE(1)
      READ (2,230) SLLGT(3),SLOPE(3)
      READ (2,230) C1,XN,A1,B1,RESIS
      READ (2,230) RDETC,EXPON,FDETC,FDETO,SHIEL
      READ (2,230) CDMAX,CVDEN,THSHD,CALDF,ENGBL,FREWT,ONTRS
      READ (2,230) PRWQV,RCHRG,(SMTM1(IMPD7),IMPD7 = 1,3)
      RETURN
C
C     VARIOUS FORMATS.
C
  140 FORMAT (20A4)
  150 FORMAT (1H1,/20X,20A4)
  160 FORMAT (I2,3F10.4)
  170 FORMAT (/20X,33HDAILY VALUES WILL NOT BE PRINTED.)
  180 FORMAT (6G10.3)
  190 FORMAT (/20X,4HDL =,5G10.3/20X,6HTHETA=,5G10.3/20X,4HFC =,5G10.3)
```

```
  200 FORMAT (/20X,5HPAIR=,G15.8,5X,4HCPO=,G15.8,5X,3HXL=,G15.8,5X,2HV=,
     1G15.8)
  210 FORMAT (/11X,2(13X,2HAT),2(11X,4HARAT),11X,2HGM,15X,2HGV/15X,6(5X,
     1G10.3))
  220 FORMAT (2I2)
  230 FORMAT (8F10.5)
  240 FORMAT (/20X,6HALBVEG,9X,5HCANON,10X,6HCANOFF,9X,5HSIMIN,10X,5HSIM
     1AX,10X,5HALMIN,10X,5HALMAX/15X,7(5X,G10.3))
  250 FORMAT (/24X,28HGRNCOV  SLLGTH(1)   SLOPE(1)/(18X,3(2X,F9.3))/)
      END
      FUNCTION PCKRF(DUMMY)
C
C     GET THE REFLECTIVITY OF THE SNOWPACK
```

FUNCTION PCKRF (DUMMY)

```
C
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , EHGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWOV       , RCHRG       ,
     4        SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER                DREDY       , PHASE
      COMMON /WTRBL/        ETFRM       , EVPTR       , GENRO       ,
     1        PRCIP       , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX       , TMPMN       , WTRIN
C
C     DICTIONARY
C
C     PSTNT - A VARIABLE SET EQUAL TO - NDYSN - AND ALTERED AS NEEDED
C                 TO CHOOSE THE PROPER REFLECTIVITY FUNCTION
C     RFCUM - A REFLECTIVITY FUNCTION FOR THE SNOWPACK DURING THE
C                 ACCUMULATION PHASE OF THE SNOWPACK
C     RFMLT - A REFLECTIVITY FUNCTION FOR THE SNOWPACK DURING THE
C                 MELT PHASE OF THE SNOWPACK
C
      DIMENSION             RFCUM(15)   , RFMLT(15)
      INTEGER               PSTNT
      DATA RFCUM/.80,.77,.75,.72,.70,.69,.68,.67,.66,.65,.64,.63,.62,.61
     1,.60/
      DATA RFMLT/.72,.65,.60,.58,.56,.54,.52,.50,.48,.46,.44,.43,.42,.41
     1,.40/
      PSTNT = NDYSN
      IF (PSTNT.EQ.0) PSTNT = 1
      IF (NDYSN) 170,170,100
C
C     USE THE SAME FUNCTION AS LAST TIME
C
  100 IF (LSTUS) 110,110,140
C
C     ACCUMULATION PHASE - AFTER 15 DAYS, USE THE MELT FUNCTION
C      STARTING AT THE FOURTH DAY
C
  110 IF (PSTNT - 15) 120,120,130
  120 PCKRF = RFCUM(PSTNT)
      RETURN
  130 PSTNT = PSTNT - 11
C
C     MELT FUNCTION - AFTER 15 DAYS, USE A CONSTANT 40 PERCENT
C
  140 IF (PSTNT - 15) 160,160,150
  150 PSTNT = 15
  160 PCKRF = RFMLT(PSTNT)
      RETURN
C
C     THERE IS NEW SNOW - DETERMINE IF THE FUNCTION IS TO BE RE-
C      INITIALIZED
C
  170 IF (TMPMX - THSHD) 180,180,100
```

```
C
C     IT IS, SO SEE WHICH FUNCTION IS TO BE USED
C
  180 IF (CALDF) 200,200,190
  190 PCKRF = 0.91
      LSTUS = 0
      RETURN
C
C     THE PACK IS ISOTHERMAL, BUT IF THE ENERGY BALANCE FROM THE
C      PREVIOUS DAY WAS NEGATIVE, USE THE ACCUMULATION PHASE
C      FUNCTION ANYWAY
C
  200 IF (ENBL1) 190,210,210
  210 PCKRF = 0.81
      LSTUS = 1
      RETURN
      END
```

SUBROUTINE PROSP

```
      SUBROUTINE PROSP

C
C     PROSP IS A ROUTINE IN WHICH THE WATER FLUXES ARE CALCULATED.
C
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FO1(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , BI          , CI           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DDRAI        , DRUN        , ET           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GM           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , [illegible]  , MO           , MOBEG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RR1          ,
     I        RRR          , RX          , SFV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
      COMMON /BLOK2/        SIMIN        , SLAT         , STIME        ,
     1        SUN1         , SUN2        , TEMP1        , TEMP2        ,
     2        TOTVO        , TP          , TPRES        , TRCAN        ,
     3        V            , XL          , XN           , Z
      COMMON /BLOK3/        ETDNM        , ETNUM        , IC           ,
     1        IVAP         , RDENM       , RNUM
      COMMON /BLOK4/        CR1          , PFC(2)       , ROOTC(2)     ,
     1        ROOTK(2)     , SNPRS
      COMMON /EMBLK/        CCAL(51)     , CMAT(51)     , CUMEX(300)   ,
     1        DEGSA(51,2)  , DP(51)      , DPI(51)      , EX(300)      ,
     2        EXNEW(200)   , EXTTM(300)  , EXTNE(200)   , MULTD(366)   ,
     3        PRFCI(366)   , RAIN(200)   , RAINT(200)   , RELCO(51,2)  ,
     4        ROLD(200)    , RTOLD(200)  , SLCON(51,2)  , SLPOT(51,2)  ,
     5        SOLAR(366)   , SPCH(51)    , TEMP(366)    , TEMPH(366)   ,
     6        TEMPL(366)   , THSOI(51)   , TINC(51)     , TSOIL(51)    ,
     7        VAPOR(366)   , VOL1(5,40)  , WATCO(51,2)
      DIMENSION             CHETA(5)     , DTHEO(5)     , DTHET(5)     ,
     1        PSM(5)       , RROOT(2)    , RS(5)        , RSBL(5)      ,
     2        SWFBL(4)     , THETO(5)    , ZS(5)
```

```
C
C     INITIALIZATION.
C
      RUN = 0.0
      STORE = (1.0 - CANCO) * GRNCO * SIGRN + CANCO * (SIMIN + (ALEAF/AL
     1MAX) * (SIMAX - SIMIN))
      SIGMA = 1.0 + ALEAF/ALMAX
      RO = 6.0 - ALEAF * (5.0 - 2.0 * (DATEJ - CANON)/(CANOF - CANON))/A
     1LMAX
      WMAXS = STORE - SI
      SINIT(1) = THETA(1)/(POROS(1) * DL(1))
      IF (PRECI(ITIME) .LE. 0.0) GO TO 140
      IF (KJ .GT. 0) GO TO 120
      WRITE (61,410) ITIME,(THETA(IMPD1),IMPD1 = 1,5)
      DO 110 LP110 = 1,5
         SINIT(LP110) = THETA(LP110)/(POROS(LP110) * DL(LP110))
         IF (LP110 .GT. 2) GO TO 100
         CALL SUCT (LP110)
         GO TO 110
  100    SAVE(LP110) = SAVE(2)
  110 CONTINUE
      CALL VOLUM
  120 KJ = KJ + 1
      FO = FO1(KJ)
      DO 130 LP130 = 1,5
         DTHET(LP130) = VOL1(LP130,KJ)
         WRITE (61,420) LP130,DTHET(LP130)
         IF (DTHET(LP130) .LE. 0.0) DTHET(LP130) = 0.0
  130 CONTINUE
      IF (KJ .EQ. NDAYS) KJ = 0
      GO TO 160
  140 DO 150 LP150 = 1,5
         DTHET(LP150) = 0.0
  150 CONTINUE
C
C     INTERCEPTION WHEN PRECIPITATION IS LESS THAN INTERCEPTION STORAGE.
C
  160 IF (PRECI(ITIME) .GE. WMAXS) GO TO 170
      SI = SI + PRECI(ITIME)
      FILT = 0.0
      GO TO 180
C
C     INTERCEPTION WHEN PRECIPITATION IS GREATER THAN INTERCEPTION.
C
  170 FILT = PRECI(ITIME) - WMAXS
      SI = STORE
C
C     INITIALIZATION OF SEASONALLY DEPENDENT VARIABLES.
C
  180 IF (PRECI(ITIME) .LE. 0.0) GO TO 190
      RUN = FILT - FO
      IF (RUN .LE. 0.0) RUN = 0.0
  190 G = GROUN (GM,GV,DATEJ,PI)
      NPRE = 0
      NRAD = 0
C
      RX = 0.0
C
C     CALCULATE POTENTIAL EVAPORATION FROM INTERCEPTION.
C
      IVAP = 0
      CALL EVAP (RN,G,TPRES,ET,IVAP)
      IVAP = 1
      IF (ET .GT. SI) GO TO 200
C
C     EVAPORATION FROM INTERCEPTION.
C
      SI = SI - ET
      QI = ET
      ET = 0.0
      SEV = 0.0
      RX = RRR
      SWRF1 = 0.0
      SWRF2 = 0.0
```

```
      NPRE = 1
      GO TO 210
  200 RN = RN - HT * SI
      QI = SI
      SI = 0.0
      IF (RN .LT. G) NRAD = 1
  210 ITER = IFIX (360.0/DL(1)) * (1 + IFIX (FILT)) + NDRN
      XDIS = FLOAT (ITER)
      DO 220 LP220 = 1,5
         DTHEO(LP220) = DTHET(LP220)/XDIS
         THETO(LP220) = 0.0
  220 CONTINUE
      ETOTA = 0.0
      STOTA = 0.0
      RUNTO = 0.0
      DRNTO = 0.0
      SWBTO = 0.0
      RF1TO = 0.0
      RF2TO = 0.0
      DO 400 LP400 = 1,ITER
C
C     CALCULATE MATRIC POTENTIAL OF THE SOIL LAYERS.  DATA ARE NOT
C     AVAILABLE AT PRESENT FOR LAYERS 3 TO 5.  IN THE PRESENT VERSION
C     THESE LAYERS ARE CONSIDERED TO HAVE THE SAME CHARACTERISTICS
C     AS THOSE IN LAYER 2.
C
         KNDEX = 2
         DO 230 LP230 = 1,5
            KK230 = 5 - LP230 + 1
            CHETA (KK230) = THETA(KK230)/DL(KK230)
            IF (KK230 .EQ. 1) KNDEX = 1
            CALL TABLO (CHETA(KK230),PSM(KK230),ZS(KK230),KNDEX)
  230    CONTINUE
         IF (LP400 .NE. ITER) GO TO 250
         DO 240 LP240 = 1,5
            DTHEO(LP240) = DTHET(LP240) - THETO(LP240)
  240    CONTINUE
         WRITE (61,430) (CHETA(IMPD2),PSM(IMPD2),ZS(IMPD2),IMPD2 = 1,5)
C
C     CALCULATE TOTAL SOIL WATER POTENTIAL.
C
  250    XXX = 0.0
         DO 260 LP260 = 1,5
            PSI(LP260) =  - PSM(LP260) - DL(LP260)/2.0 - XXX
            XXX = XXX + DL(LP260)
  260    CONTINUE
C
C     CALCULATE ELECTRICAL ANALOG RESISTANCE TERMS.
C
         DO 270 LP270 = 1,5
            RS(LP270) = DL(LP270)/(2.0 * ZS(LP270))
  270    CONTINUE
         DO 280 LP280 = 1,2
            RRAT = ROOTC(LP280) * (1.0/ZS(LP280)) *  * ROOTK(LP280)
            IF (ABS (PSI(LP280)) .LE. PFC(LP280)) RRAT = CR1
            IF (ABS (PSI(LP280)) .GE. 15000.0) RRAT = 1.0E30
            RROOT(LP280) = RRAT * DL(LP280)/(2.0 * ZS(LP280) * AT(LP280)
     1      )
  280    CONTINUE
         RR1 = RROOT(1)
         DO 300 LP300 = 1,4
            IF (PSI(LP300) .GT. PSI(LP300 + 1)) GO TO 290
            RSBL(LP300) = RS(LP300 + 1) * (1.0 + 9.0 * RS(LP300)/(8.0 *
     1      RS(LP300 + 1) + RS(LP300)))
            GO TO 300
  290       RSBL(LP300) = RS(LP300) * (1.0 + 9.0 * RS(LP300 + 1)/(8.0 *
     1      RS(LP300) + RS(LP300 + 1)))
  300    CONTINUE
         FAC = 9.0 * (1.0 + 3.8/(ALEAF *  * 2))/(3.8 * AMAX1 (CANCO,1.0E
     1    - 10))
         R1 = RSBL(1)
         R2 = DL(2) * AT(2)/(ZS(2) * ALEAF * ARAT(2)) + FAC * (RROOT(2)
     1   + RR1/2.0)
         R3 = RS(1)
```

```
C
C     R4 IS THE ABOVE GROUND PLANT RESISTANCE.  THIS VALUE WAS OBTAINED
C     FROM AN ESTIMATE BY COWAN.
C
      R4 = (5000.0 + RR1/2.0) * FAC
      R5 = FAC * DL(1) * AT(1)/(ZS(1) * ALEAF * ARAT(1))
      RX = 0.0
      IF (NPRE .EQ. 1) GO TO 350
      IF (NRAD .EQ. 1) GO TO 330
C
C     SOLVE FOR SURFACE WATER POTENTIAL = PWP.
C
      IC = 0
      CALL SOLVO
      IF (PWP .GT. PSI(1)) GO TO 310

C
C     CALCULATE EVAPOTRANSPIRATION = ET.
C
      ET = (RNUM - PWP)/RDENM
      GO TO 320
  310 PWP = PSI(1) - 100.0
      CALL EVAP (RN,G,TPRES,ET,IVAP)
  320 IF (ET .GT. 0.0) GO TO 340
  330 ET = 0.0
      SEV = 0.0
      SWRF1 = 0.0
      SWRF2 = 0.0
      GO TO 350
C
C     CALCULATE SOIL EVAPORATION = SEV.
C
  340 ET = ET/XDIS
      SEV = (PSI(1) - PWP)/((R3 + RLIT) * XDIS)
C
C     CALCULATE PLANT TRANSPIRATION.
C
      ET = ET - SEV
C
C     CALCULATE WATER FLUXES.
C
      SWRF1 = ET * R2/(R2 + R5)
      SWRF2 = ET - SWRF1
C
C     CALCULATE SOIL WATER CONTENT.
C
  350 DO 360 LP360 = 1,4
         SWFBL(LP360) = (PSI(LP360) - PSI(LP360 + 1))/RSBL(LP360)
  360 CONTINUE
      THETA(1) = THETA(1) + DTHEO(1) - SWFBL(1)/XDIS - SWRF1 - SEV
      THETA(2) = THETA(2) + DTHEO(2) + (SWFBL(1) - SWFBL(2))/XDIS - S
     1 WRF2
      THETA(3) = THETA(3) + DTHEO(3) + (SWFBL(2) - SWFBL(3))/XDIS
      THETA(4) = THETA(4) + DTHEO(4) + (SWFBL(3) - SWFBL(4))/XDIS
      THETA(5) = THETA(5) + DTHEO(5) + SWFBL(4)/XDIS
      FLNET = (SWFBL(1) + SWFBL(2) + SWFBL(3) + SWFBL(4))/XDIS
C
C     WHEN THE SOIL LAYERS ARE SATURATED, THEY CANNOT ACCEPT ANY MORE
C     WATER.  IN THIS CASE , THE WATER IS REMOVED FROM THE SYSTEM AND
C     GROUPED UNDER A GENERAL TERM OF RUNOFF.
C
      DRUN = 0.0
      DO 370 LP370 = 1,5
C
C     CALCULATE RUNOFF FROM LP370TH LAYER.
C
         IF (THETA(LP370) .LE. S(LP370)) GO TO 370
         FF = THETA(LP370) - S(LP370)
         DRUN = DRUN + FF/XDIS
         THETA(LP370) = THETA(LP370) - FF/XDIS
  370 CONTINUE
      IF (THETA(5) .LE. F) GO TO 380
```

```
C
C     CALCULATE DRAINAGE.
C
        DDRAI = ZS(5)/XDIS
        AMOUN = (THETA(5) - F)/3.0
        IF (AMOUN .LT. ZS(5)) DDRAI = AMOUN/XDIS
        THETA(5) = THETA(5) - DDRAI
  380   DO 390 LP390 = 1,5
           THETO(LP390) = THETO(LP390) + DTHEO(LP390)
  390   CONTINUE
        ETOTA = ETOTA + ET
        STOTA = STOTA + SEV
        RUNTO = RUNTO + DRUN
        DRNTO = DRNTO + DDRAI
        SWBTO = SWBTO + FLNET
        RF1TO = RF1TO + SWRF1
        RF2TO = RF2TO + SWRF2
        ET = ETOTA
  400 CONTINUE
      PERRU = PERRU + RUN
      SEV = STOTA
      DRUN = RUNTO + RUN
      DDRAI = DRNTO
      FLNET = SWBTO
      SWRF1 = RF1TO
      SWRF2 = RF2TO
      NDRN = ITER/2
      SNPRS = CHETA(1)/POROS(1)
      RETURN
C
C     VARIOUS FORMATS.
C
  410 FORMAT (20X,14HVOL(I) ON DAY ,I5,23H BEFORE CALL TO VOLUME.,/(20X,
     15(F12.5,2X)))
  420 FORMAT (20X,7HDTHETA(,I2,3H) =,F12.5)
  430 FORMAT (/48X,5HCHETA,11X,3HPSM,12X,2HZS/(39X,3(2X,F12.5)))
      END
```

SUBROUTINE RADBL

```
      SUBROUTINE RADBL
C
C     THIS PROGRAM UNIT COMPUTES THE RADIATION BALANCE AND TRANSFERS
C      CONTROL TO THE DIFFUSION MODEL IF IT IS NEEDED
C
      COMMON /ONLCR/        AVTMC      , BSTMF      , CALDF      ,
     1        CDMAX       , CVDEN      , DREDY      , ENGBL      ,
     2        ENBL1       , FREWT      , LSTUS      , NDYSN      ,
     3        ONTRS       , PHASE      , PRWOV      , RCHRG      ,
     4        SMTM1(3)    , SMTMJ      , TCOEF      , THSHD
      INTEGER               DREDY      , PHASE
      COMMON /WTRBL/        ETFRM      , EVPTR      , GENRO      ,
     1        PRCIP       , RADIN      , RDLWN      , RDSWN      ,
     2        TMPMX       , TMPMN      , WTRIN
C
C     DICTIONARY
C
C     CLAIR - POTENTIAL LONGWAVE CALORIC INPUT AT AIR TEMPERATURE
C     CALRE - CALORIES OF HEAT ABSORBED OR RELEASED BY THE SNOWPACK
C                FROM THE NET RADIATION BALANCE
C
C     CLSNW - POTENTIAL LONGWAVE CALORIC LOSS AT SNOW TEMPERATURE
C     SNCAN - THE LONGWAVE RADIATION BALANCE BETWEEN THE SNOW AND THE
C                CANOPY
C     SNSKY - THE LONGWAVE RADIATION BALANCE BETWEEN THE SNOW AND THE
C                SKY
C     COMPUTE THE CALORIC INPUT FROM NET SHORT WAVE RADIATION AS A
C      FUNCTION OF THE SNOWPACK REFLECTIVITY
```

```
C
      RDSWN = RADIN * (1.0 - PCKRF(0.0)) * TCOEF
C
C     IF THE PACK IS ACCUMULATING, BUT IS NOT DEEP ENOUGH FOR STABILITY
C      IN THE DIFFUSION MODEL, USE THE FOLLOWING SIMPLIFIED METHOD FOR
C      DERIVING THE RADIATION BALANCE
C
      IF (PHASE) 150,100,190
  100 IF (PRWQV - 4.7) 110,140,140
C
C     USE ONLY THE SHORTWAVE INPUT (THIS IMPLIES THAT THE ONLY COLD
C      CONTENT GENERATED IN THE ACCUMULATING PACK IS THAT OF NEW SNOW)
C
  110 CALRE = RDSWN
      RDLWN = 0.0
      CALL CALIN (CALRE)
C
C     IF THE MEAN TEMPERATURE WAS LESS THAN OR EQUAL TO 0 C, DO NOT
C      ALLOW ANY MELT OR FREE WATER
C
      IF (AVTMC) 120,120,130
  120 PRWQV = PRWQV + WTRIN
      RDLWN =  - ENGBL
      ENGBL = 0.0
      WTRIN = 0.0
      FREWT = 0.0
      CALDF = 0.0
  130 RETURN
C
C     THE PACK HAS JUST REACHED A SUFFICIENT DEPTH.  INITIALIZE THE
C      DIFFUSION MODEL, BUT RETAIN PSEUDO-CONTROL UNTIL THE DIFFUSION
C      MODEL IS WELL ALONG INTO STABLE CONTROL
C
  140 PHASE =  - 1
      DREDY = 1
C
C     START THE PACK AT -3 C (CAL DEF = PACK TEMP * PRWQV * 1.27)
C     3.81 = 3 * 1.27
C
C     THE CHANGE FROM (CALDF = 3.81 * PRWQV) TO (CALDF = 0.0) WAS MADE
C     BY TED COMBS FOR THE PROGRAM MERGER.
C
C     CALDF = 3.81 * PRWQV
C
      CALDF = 0.0
      RDLWN =  - CALDF - RDSWN - ENGBL
      ENGBL =  - CALDF
      SMTM1(1) = AMIN1(AVTMC,0.0)
      SMTM1(2) =  - 3.0
      SMTM1(3) =  - 1.5
      FREWT = 0.0
      RETURN
C
C     THE DIFFUSION MODEL HAS BEEN INITIALIZED PREVIOUSLY.  IF IT IS
C      STILL STABLE AND IF THE PACK IS DEEP ENOUGH TO INSURE CONTINUED
C      STABILITY UNTIL MELT, RELINQUISH CONTROL COMPLETELY TO THE
C      NORMAL METHOD OF COMPUTING THE RADIATION BALANCE, INTERFACED WITH
C      THE DIFFUSION MODEL
C
  150 IF (DREDY) 190,160,170
  160 IF (AVTMC .GT. 0.0) GO TO 110
      PHASE = 0
      GO TO 100
  170 CALRE = RDSWN
      CLAIR = 0.0
      RDLWN = 0.0
      IF (PRWQV - 5.0) 250,250,180
  180 PHASE = 1
C
C     USE THE NORMAL METHOD OF COMPUTING THE RADIATION BALANCE.  IF ANY
C      OF THE PRECIPITATION WAS SNOW, THE NET LONG WAVE RADIATION
C      BALANCE IS ASSUMED TO BE ZERO
C
  190 IF (NDYSN) 200,200,210
```

```
  200 RDLWN = 0.0
      CLAIR = 0.0
      GO TO 240
C
C     TO COMPUTE THE LONG WAVE RADIATION COMPONENTS, CONVERT THE AIR
C      AND SNOW TEMPERATURES TO POTENTIAL CALORIES BY THE STEFAN -
C      BLOTZMANN FUNCTION, CALORIES = S * (T**4), WHERE
C      S = 1.17E-7 CAL/((CM**2)(DEGREES KELVIN)**4), AND
C      T = ABSOLUTE TEMPERATURE (DEGREES KELVIN)
C
  210 CLAIR = 1.17E - 7 * ((AVTMC + 273.16) *  * 4)
      USE = AVTMC
C
C     IF THE SNOWPACK IS ISOTHERMAL, USE THE MINIMUM TEMPERATURE FOR
C      COMPUTING THE BACK RADIATION
C
      IF (CALDF.EQ.0.0) USE = (TMPMN - 32.0) * 5.0/9.0
C
C     UNDER NO CIRCUMSTANCES MAY THE TEMPERATURE FOR COMPUTING THE BACK
C      RADIATION BE GREATER THAN ZERO
C
      IF (USE.GT.0.0) USE = 0.0
      CLSNW = 1.17E - 7 * ((USE + 273.16) *  * 4)
C
C     COMPUTE THE LONG WAVE RADIATION COMPONENTS AS A FUNCTION OF THE
C      FIRST, DETERMINE WHETHER THE SKIES ARE CLEAR OR CLOUDY
C
      IF (PRCIP) 220,220,230
C
C     WITH CLEAR SKIES, THE DOWNWARD LONGWAVE RADIATION COEFFICIENT IS
C       757 (RUNOFF FROM SNOWMELT, EM1110-2-1406, US ARMY CORPS OF
C      ENGINEERS, 1960, PAGE 7)
C
  220 SNSKY = (1.0 - CVDEN) * ((0.757 * CLAIR) - CLSNW)
C
C     THE DOWNWARD LONGWAVE RADIATION COEFFICIENT IS 1.0 BENEATH THE
C      FOREST CANOPY (OR BENEATH CLOUDY SKIES)
C
      SNCAN = CVDEN * (CLAIR - CLSNW)
      RDLWN = SNCAN + SNSKY
      GO TO 240
C
C     WITH CLOUDY SKIES, WHEN THE DOWNWARD LONGWAVE RADIATION COEFFI-
C      CIENT IS 1.0 INSTEAD OF .757, THE ABOVE THREE EQUATIONS MAY BE
C      REDUCED ALGEBRAICALLY TO THE FOLLOWING SINGLE EQUATION
C
  230 RDLWN = CLAIR - CLSNW
C
C     COMPUTE THE CALORIC INPUT OR LOSS FROM THE NET EFFECT OF SHORT
C      WAVE AND LONG WAVE RADIATION
C
  240 CALRE = RDSWN + RDLWN
C
C     THE SNOWPACK TEMPERATURE DIFFUSION MODEL (LEAF, 1970, STUDY PLAN
C      FS-RM-1602, NO. 224.  ROCKY MOUNTAIN FOREST AND RANGE EXP STA) IS
C
C      INCORPORATED TO CONTROL THE SNOWPACK TEMPERATURE AND COLD CONTENT
C      DURING NON-ISOTHERMAL CONDITIONS.  SEE NOW IF THE DIFFUSION MODEL
C      MAY BE USED (DREDY MAY NOT BE -1 AND PASS THROUGH LINK SINCE IT
C      IS NOT DESIGNED TO WORK WITH IT.  THE -1 IS USED TO INDICATE THAT
C      THE RADIATION ROUTINES ARE TO BE USED EXCLUSIVELY).  IF IT MAY BE
C      USED, PASS THROUGH THE LINKING ROUTINE WHICH INTERFACES THE
C      DIFFUSION MODEL AND THE RADIATION ROUTINES
C
      IF (DREDY) 260,250,250
  250 CALL LINK (CLAIR,CALRE,IRTRN)
      IF (IRTRN) 260,260,280
  260 IF (CALRE) 270,280,290
  270 CALL CALOS (CALRE)
  280 RETURN
  290 CALL CALIN (CALRE)
      RETURN
      END
```

SUBROUTINE RADIA

```
      SUBROUTINE RADIA
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
     D        NSED        , NUMDA       , PAIR        , PER         ,
     E        PERRU       , PI          , PWP         , QI          ,
     F        R1          , R2          , R3          , R4          ,
     G        R5          , RDETC       , RESIS       , RESWA       ,
     H        RLIT        , RN          , RO          , RR1         ,
     I        RRR         , RX          , SEV         , SHIEL       ,
     J        SI          , SIGMA       , SIGRN       , SIMAX
      COMMON /BLOK2/        SIMIN       , SLAT        , STIME       ,
     1        SUN1        , SUN2        , TEMP1       , TEMP2       ,
     2        TOTVO       , TP          , TPRES       , TRCAN       ,
     3        V           , XL          , XN          , Z
      ASP1 = 270.0
      ASP2 = 90.0
      IF ((ALSR .GT. 0.0) .AND. (ALSS.GT.0.0)) GO TO 100
      PAR2 = ALSR + ALSS
      PAR1 = 0.0
      IF (PAR2 .GT. 0.0) PAR1 = (ASP1 * ALSR + ASP2 * ALSS)/PAR2
      CALL RADIT (DATEJ,SLAT,PAR1,PAR2,HSR,HSS,DUM1,DUM2,0.0)
      GO TO 110
  100 CALL RADIT (DATEJ,SLAT,ASP2,ALSR,HSR,HDUM1,DUM3,DUM4,0.0)
      CALL RADIT (DATEJ,SLAT,ASP1,ALSS,HDUM2,HSS,DUM5,DUM6,0.0)
  110 STIME = HSS - HSR
      RETURN
      END
```

FUNCTION RAIND (T)

```
      FUNCTION RAIND (T)
C
C     THIS PROGRAM UNIT DETERMINES THE APPROPRIATE RAINFALL TIME INCRE-
C     MENT CORRESPONDING TO THE TIME T.  THE PROGRAM UNIT IS USED BY
C     THE INFILTRATION PROGRAM UNIT.
C
C     PARAMETERS IN ARGUMENT LIST:
C
C        T     = TIME.
C        RAIN  = RAINFALL INTENSITY ARRAY.
C        RAINT = RAINFALL TIME ARRAY.  (RAIN AND RAINT ARE THE VALUES
C                OF THE HYETOGRAPH BEFORE AND AFTER INTERCEPTION).
C        NRAIN = THE SIZE OF THE RAIN AND RAINT ARRAYS.
C
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
```

```
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
     D        NSED        , NUMDA       , PAIR        , PER         ,
     E        PERRU       , PI          , PWP         , QI          ,
     F        R1          , R2          , R3          , R4          ,
     G        R5          , RDETC       , RESIS       , RESWA       ,
     H        RLIT        , RN          , RO          , RR1         ,
     I        RRR         , RX          , SEV         , SHIEL       ,
     J        SI          , SIGMA       , SIGRN       , SIMAX
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
     1        DEGSA(51,2) , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)  , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3        PRECI(366)  , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4        ROLD(200)   , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5        SOLAR(366)  , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6        TEMPL(366)  , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
     7        VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
      RAIND = 5.0
      DO 100 LP100 = 1,NRAIN
         IF (T .GE. RAINT(LP100)) GO TO 100
         RAIND = RAINT(LP100)
         IF (LP100 .GT. 1) RAIND = RAIND - RAINT(LP100 - 1)
         GO TO 110
  100 CONTINUE
  110 CONTINUE
      RETURN
      END
```

FUNCTION RAINI (T)

```
      FUNCTION RAINI (T)
C
C     THIS PROGRAM UNIT DETERMINES THE RAINFALL INTENSITY AT TIME T.
C     SEE PROGRAM UNIT RAIND FOR DESCRIPTION OF ARGUMENT LIST.
C
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
     D        NSED        , NUMDA       , PAIR        , PER         ,
     E        PERRU       , PI          , PWP         , QI          ,
     F        R1          , R2          , R3          , R4          ,
     G        R5          , RDETC       , RESIS       , RESWA       ,
     H        RLIT        , RN          , RO          , RR1         ,
     I        RRR         , RX          , SEV         , SHIEL       ,
     J        SI          , SIGMA       , SIGRN       , SIMAX
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
     1        DEGSA(51,2) , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)  , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3        PRECI(366)  , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4        ROLD(200)   , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
```

```
     5        SOLAR(366)  , SPCH(51)    , TEMP(366)    , TEMPH(366)  ,
     6        TEMPL(366)  , THSOI(51)   , TINC(51)     , TSOIL(51)   ,
     7        VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
      RAINI = 0.0
      DO 100 LP100 = 1,NRAIN
         IF (T .GT. RAINT(LP100)) GO TO 100
         RAINI = RAIN(LP100)
         GO TO 110
  100 CONTINUE
  110 CONTINUE
      RETURN
      END
```

SUBROUTINE RADIT (DAY, XLAT, ASP, SLP, TSR, TSS, SUM, DTYME, WATER)

```
      SUBROUTINE RADIT (DAY,XLAT,ASP,SLP,TSR,TSS,SUM,DTYME,WATER)
      COMMON /ARAYS/        ARAT(2)     , AT(2)        , CANLO(20)   ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)    ,
     2        DATE(5)      , DL(5)       , FC(5)        , FO1(40)     ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)   ,
     4        FOROS(5)     , PSI(5)      , S(5)         , SAVE(5)     ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)    ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)       ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1          , ADJTI        , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR        ,
     2        ALSS         , B1          , C1           , CANCO       ,
     3        CANOF        , CANON       , CPO          , DATEJ       ,
     4        DDRAI        , DRUN        , ET           , EXPON       ,
     5        F            , FDETC       , FDETO        , FILT        ,
     6        FLNET        , FO          , G            , GM          ,
     7        GRNCO        , GV          , HT           , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN       ,
     9        JSTAR        , K           , KJ           , KTP         ,
     A        LLDAY        , MAXDA       , MO           , MOBEG       ,
     B        NALT         , NC          , NCAN         , NCAN1       ,
     C        NDAYS        , NDRN        , NM           , NRAIN       ,
     D        NSED         , NUMDA       , PAIR         , PER         ,
     E        PERRU        , PI          , PWP          , QI          ,
     F        R1           , R2          , R3           , R4          ,
     G        R5           , RDETC       , RESIS        , RESWA       ,
     H        RLIT         , RN          , RO           , RR1         ,
     I        RRR          , RX          , SEV          , SHIEL       ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
      COMMON /BLOK2/        SIMIN       , SLAT         , STIME       ,
     1        SUN1         , SUN2        , TEMP1        , TEMP2       ,
     2        TOTVO        , TP          , TPRES        , TRCAN       ,
     3        V            , XL          , XN           , Z
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)     , CUMEX(300)  ,
     1        DEGSA(51,2)  , DP(51)      , DPI(51)      , EX(300)     ,
     2        EXNEW(200)   , EXTIM(300)  , EXTNE(200)   , MULTD(366)  ,
     3        PRECI(366)   , RAIN(200)   , RAINT(200)   , RELCO(51,2) ,
     4        ROLD(200)    , RTOLD(200)  , SLCON(51,2)  , SLPOT(51,2) ,
     5        SOLAR(366)   , SPCH(51)    , TEMP(366)    , TEMPH(366)  ,
     6        TEMPL(366)   , THSOI(51)   , TINC(51)     , TSOIL(51)   ,
     7        VAPOR(366)   , VOL1(5,40)  , WATCO(51,2)
      DATA IFLAG/0/
      IF (IFLAG .LT. 0) GO TO 100
      C0 = 2.0 * PI/365.0
      C2 = PI/180.0
      C3 = PI/12.0
      DMAX = SIN (23.445 * C2)
      IFLAG = -1
```

```
100 AZM = ASP * C2
    C4 = XLAT * C2
    X = SIN (SLP) * COS (AZM) * COS (C4) + COS (SLP) * SIN (C4)
    IF (ABS (X) .GT. 1.0) X = SIGN (1.0,X)
    ALP = ATAN (SIN (AZM) * SIN (SLP)/(COS (SLP) * COS (C4) - COS (AZM
   1) * SIN (SLP) * SIN (C4)))
    C5 = ATAN2 (X,SQRT (1.0 - X * X))
    D = 2.0 * PI * (DAY - 1.0)/365.242
    S0 = C2 * (279.9348 + D/C2 + 1.914827 * SIN (D) - 0.079525 * COS (
   1D) + 0.019938 * SIN (2.0 * D) - 0.00162 * COS (2.0 * D))
    X = SIN (S0) * DMAX
    IF (ABS (X) .GT. 1.0) X = SIGN (1.0,X)
    DELT = ATAN2 (X,SQRT (1.0 - X * X))
    R = 1.0 + 0.017 * COS (C0 * (186.0 - DAY))
    HASR =  - TAN (C4) * TAN (DELT)
    IF (ABS (HASR) .GT. 1.0) HASR = SIGN (1.0,HASR)
    AHSR = ATAN2 (SQRT (1.0 - HASR * HASR),ABS (HASR))
    AASR =  - TAN (C5) * TAN (DELT)
    IF (ABS (AASR) .GT. 1.0) AASR = SIGN (1.0,AASR)
    ABSR = ATAN2 (SQRT (1.0 - AASR * AASR),ABS (AASR))
    ABSS = ABSR
    IF (AASR .LT. 0.0) ABSS = PI - ABSR
    IF (AASR .GT. 0.0) ABSR = 2.0 * PI - ABSR
    IF (AASR .LT. 0.0) ABSR = PI + ABSR
    ABSS = ABSS - ALP
    ABSR = ABSR - ALP
    AHSS = AHSR
    IF (HASR .LT. 0.0) AHSS = PI - AHSR
    IF (HASR .GT. 0.0) AHSR = 2.0 * PI - AHSR
    IF (HASR .LT. 0.0) AHSR = PI + AHSR
    IF (AHSR .LT. ABSR) AHSR = ABSR
    IF (AHSS .GT. ABSS) AHSS = ABSS
    X1 = SIN (C5) * SIN (DELT)
    X2 = COS (C5) * COS (DELT)
    TSR = AHSR/C3 - 24.0
    TSS = AHSS/C3
    SUM = 120.0/(R * R) * ((TSS - TSR) * X1 + 1.0/C3 * X2 * (SIN (TSS
   1* C3 + ALP) - SIN (TSR * C3 + ALP)))
    IF (SUM .LT. 0.0) SUM = 0.0
    IF (WATER .LE. 0.0) GO TO 140
    HAI = AHSR
    CUMEX(1) = 0.0
    EX(1) = 0.0
    EXTIM(1) = (TSR + 12.0) * 60.0
    DO 110 LP110 = 2,200
       KK110 = LP110
       EX(LP110) = 0.0
       EXTIM(LP110) = EXTIM(LP110 - 1) + DTYME
       HAI = HAI + DTYME * C3/60.0
       IF (HAI .GT. 24.0 * C3) HAI = HAI - 24.0 * C3
       ASYN = X1 + X2 * COS (HAI)
       IF (ASYN .LT. 0.0) GO TO 120
       EX(LP110) = 2.0 * ASYN/(R * R) * WATER/SUM * 2.54
       CUMEX(LP110) = CUMEX(LP110 - 1) + EX(LP110) * DTYME
110 CONTINUE
    WRITE (6,150) JJJ,DATEJ
    CALL EXIT
120 CUMEX(KK110) = CUMEX(KK110 - 1)
    TOTVO = CUMEX(KK110)
    IF (TOTVO .LE. 0.0) GO TO 140
    ISTOR = ISTOR + 1
    K = KK110
    KTP = 1
    NUMDA = IFIX (DAY)
    TP = 0.0
    IF (PRECI(ITIME) .GT. 0.0) GO TO 130
    DATE(1) = 4HNO R
    DATE(2) = 4HAIN-
    DATE(3) = 4H-SNO
    DATE(4) = 4HW RU
    DATE(5) = 4HNOFF
    NRAIN = 2
```

```
      RAIN(1) = 0.0
      RAINT(1) = 0.0
      RAIN(2) = 0.0
      RAINT(2) = DTYME
  130 CALL EXCOU
      CALL RUNOU
  140 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  150 FORMAT (20X,36HERROR IN PROGRAM UNIT RADIT ON PLANE,1X,I4,1X,14HON
     1 JULIAN DATE,1X,F5.1,1X,1H.)
      END
```

SUBROUTINE RASNO (TFORN, AMTRN)

```
      SUBROUTINE RASNO (TFORN,AMTRN)
C
C     THIS PROGRAM UNIT COMPUTES THE EFFECT OF RAIN ON SNOW
C
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWOV       , RCHRG       ,
     4        SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER               DREDY       , PHASE
C
C     DICTIONARY
C     AMTRN - THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN (INCHES)
C     CALRN - THE DEPLETION OF THE TOTAL CALORIE DEFICIT BY THIS RAIN
C                 (CALORIES)
C     TFORN - THE TEMPERATURE FOR COMPUTING THE DEPLETION OF THE TOTAL
C                 CALORIE DEFICIT CAUSED BY THIS RAIN (DEGREES C)
C
C     ADD THIS AMOUNT OF PRECIPITATION TO THE PREDICTED WATER EQUIVALENT
C
      PRWOV = PRWOV + AMTRN
C
C     SEE IF THERE IS A CALORIE DEFICIT IN THE PACK
C
      IF (CALDF) 140,140,100
C
C     COMPUTE THE AMOUNT OF RAIN AT THIS TEMPERATURE THAT IS NEEDED TO
C      WIPE OUT THE DEFICIT AND COMPARE IT WITH THE ACTUAL AMOUNT
C
  100 CALRN = (80.0 + TFORN) * 2.54
      AMTND = CALDF/CALRN
      CMPAR = AMTRN - AMTND
      IF (CMPAR) 120,110,130
C
C     THERE WAS JUST ENOUGH TO WIPE OUT THE DEFICIT
C
  110 CALDF = 0.0
      ENGBL = ENGBL + CALRN
      RETURN
C
C     THERE WAS NOT ENOUGH TO WIPE IT OUT COMPLETELY.  JUST DEPLETE
C      THE DEFICIT
C
  120 CALDF = CALDF - (CALRN * AMTRN)
      ENGBL = ENGBL + (CALRN * AMTRN)
      RETURN
C
C     THERE WAS MORE THAN ENOUGH TO WIPE OUT THE DEFICIT.  THE AMOUNT
C      OF RAIN NOT FROZEN IS FREE WATER
C
```

```
  130 FREWT = CMPAR
      ABCDE = TFORN * CMPAR * 2.54
      CALL CALIN (ABCDE)
      RETURN
C
C     ALL OF THE RAIN IS ADDED TO THE FREE WATER AND CONTRIBUTES CALORIC
C      INPUT TO THE PACK
C
  140 FREWT = FREWT + AMTRN
      ABCDE = TFORN * AMTRN * 2.54
      CALL CALIN (ABCDE)
      RETURN
      END
```

SUBROUTINE RDCMP (DATEJ, DASYR, RDHRZ, RADIN, MONTH, EVPTR)

```
      SUBROUTINE RDCMP (DATEJ,DASYR,RDHRZ,RADIN,MONTH,EVPTR)
C
C     THIS PROGRAM UNIT COMPUTES THE SLOPE AND ASPECT CORRECTION FACTOR
C     FOR THE INCOMING HORIZONTAL RADIATION AND IT COMPUTES THE
C     POTENTIAL EVAPOTRANSPIRATION.
C
C     DATEJ - JULIAN DATE OF THE PRESENT DAY.
C     DASYR - JULIAN DATE OF DECEMBER 31 IN THE PRESENT SIMULATION
C             YEAR.
C     EVPTR - POTENTIAL EVAPOTRANSPIRATION.
C     MONTH - MONTH OF THE CALENDAR YEAR.
C     PTRAD - POTENTIAL RADIATION.
C     RDHRZ - INCOMING HORIZONTAL RADIATION.
C     RADIN - INCOMING RADIATION CORRECTED FOR SLOPE AND ASPECT.
C     SFCTR - SLOPE AND ASPECT CORRECTION FACTOR.
C
      COMMON /SHINE/        ETDAY(12)   , NSLAS       , POTNT(52)   ,
     1        SADAT(52)   , SLASP(52)
C
C     FIND THE CORRECT INTERPOLATION INTERVAL.
C
      DO 100 I = 1,NSLAS
         K = I
         CHECK = DATEJ - SADAT(K)
         IF (ABS (CHECK).LT.0.1) GO TO 140
         IF (CHECK) 110,140,100
  100 CONTINUE
      K = NSLAS + 1
  110 CONTINUE
C
C     COMPUTE END POINTS OF THE INTERPOLATION INTERVAL.
C
      IF ((K.GE.2).AND.(K.LE.NSLAS)) GO TO 120
      PONE = POTNT(NSLAS)
      PTWO = POTNT(1)
      YONE = SLASP(NSLAS)
      YTWO = SLASP(1)
      XONE = SADAT(NSLAS)
      XTWO = SADAT(1) + DASYR
      DAY = DATEJ
      IF (K.EQ.1) DAY = DATEJ + DASYR
      GO TO 130
  120 CONTINUE
```

```
      PONE = POTNT(K - 1)
      PTWO = POTNT(K)
      YONE = SLASP(K - 1)
      YTWO = SLASP(K)
      XONE = SADAT(K - 1)
      XTWO = SADAT(K)
      DAY = DATEJ
  130 CONTINUE
C
C     CALCULATE CORRECTION FACTORS.
C
      SFCTR = YONE + ((YTWO - YONE)/(XTWO - XONE)) * (DAY - XONE)
      PTRAD = PONE + ((PTWO - PONE)/(XTWO - XONE)) * (DAY - XONE)
      GO TO 150
  140 SFCTR = SLASP(K)
      PTRAD = POTNT(K)
C
C     COMPUTE CORRECTED RADIATION INPUT.
C
  150 RADIN = RDHRZ * SFCTR
C
C     CALCULATE POTENTIAL EVAPOTRANSPIRATION.
C
      EVPTR = ETDAY(MONTH) * RDHRZ/PTRAD
      RETURN
      END
```

SUBROUTINE RUNOU

```
      SUBROUTINE RUNOU
      COMMON /ARAYS/        ARAT(2)      , AT(2)        , CANLO(20)    ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)      , CCOVT(3)     ,
     2        DATE(5)      , DL(5)       , FC(5)        , FOI(40)      ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)       , PERSZ(11)    ,
     4        POROS(5)     , PSI(5)      , S(5)         , SAVE(5)      ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)     , SLOPE(3)     ,
     6        SW(5)        , THETA(5)    , TWATC(12)    , VP(5)        ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI        , ALBGR        ,
     1        ALBVE        , ALEAF       , ALMAX        , ALSR         ,
     2        ALSS         , B1          , C1           , CANCO        ,
     3        CANOF        , CANON       , CPO          , DATEJ        ,
     4        DORAI        , DRUN        , ET           , EXPON        ,
     5        F            , FDETC       , FDETO        , FILT         ,
     6        FLNET        , FO          , G            , GM           ,
     7        GRNCO        , GV          , HT           , IPLAN        ,
     8        ISTOR        , ITIME       , JJJ          , JPLAN        ,
     9        JSTAR        , K           , KJ           , KTP          ,
     A        LLDAY        , MAXDA       , MO           , MOREG        ,
     B        NALT         , NC          , NCAN         , NCAN1        ,
     C        NDAYS        , NDRN        , NM           , NRAIN        ,
     D        NSED         , NUMDA       , PAIR         , PER          ,
     E        PERRU        , PI          , PWP          , QI           ,
     F        R1           , R2          , R3           , R4           ,
     G        R5           , RDETC       , RESIS        , RESWA        ,
     H        RLIT         , RN          , RO           , RR1          ,
     I        RRR          , RX          , SEV          , SHIEL        ,
     J        SI           , SIGMA       , SIGRN        , SIMAX
      COMMON /BLOK2/        SIMIN        , SLAT         , STIME        ,
     1        SUN1         , SUN2        , TEMP1        , TEMP2        ,
     2        TOTVO        , TP          , TPRES        , TRCAN        ,
     3        V            , XL          , XN           , Z
      WRITE (11) JJJ,ISTOR,TOTVO,SUN1,SUN2,TEMP1,TEMP2,TWATC(MO),STIME,C
     1ANCO,GRNCO
      RETURN
      END
```

SUBROUTINE SATVP (TT, ESTAR, DEDT)

```
      SUBROUTINE SATVP (TT,ESTAR,DEDT)
C
C     THIS PROGRAM UNIT COMPUTES THE SATURATION VAPOR PRESSURE AND ITS
C     DERIVATIVE WITH RESPECT TO TEMPERATURE USING THE GOFF-GRATCH
C     FORMULA.
C
C     PARAMETERS.
C
C        ESTAR = SATURATION VAPOR PRESSURE.
C        DEDT  = DERIVATIVE OF SATURATION VAPOR PRESSURE WITH RESPECT
C                TO TEMPERATURE.
C
      IF (TT .EQ. 0.0) GO TO 100
      IF (TT .LT. 273.16) TT = 273.16
      TS = 373.16/TT
      TSM1 = TS - 1.0
      DTSDT =  - 373.16/TT *  * 2
      CC10 = 10.0 *  * ( - 11.344 * TSM1)
      C = 1.3816 * 0.0000001 * (CC10 - 1.0)
      DL10 = ALOG (10.0)
      DCDT = 1.3816 * 0.0000001 * CC10 * DL10 * (11.344 * TS)
      DE3 = 10.0 *  * ( - 3.49149 * TSM1)
      D = 8.1328 * 0.001 * (DE3 - 1.0)
      DDDT = 8.1328 * 0.001 * DE3 * DL10 * ( - 3.49149 * DTSDT)
      ESTAR = 10.0 *  * ( - 7.90298 * TSM1 + 5.02808 * ALOG10 (TS) - C +
     1 D)
      DEDT = ESTAR * DL10 * (( - 7.90298 + 5.02808 * 0.43429/TS) * DTSDT
     1 + DCDT + DDDT)
      GO TO 110
  100 ESTAR = 0.0
      DEDT = 0.0
  110 CONTINUE
      RETURN
      END
```

SUBROUTINE SNOWD (TFOSM, AMSNW)

```
      SUBROUTINE SNOWD (TFOSN,AMSNW)
C
C     THIS PROGRAM UNIT COMPUTES THE EFFECTS OF A SNOW EVENT ON THE
C      SNOWPACK
C
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS         , B1          , C1          , CANCO       ,
     3        CANOF        , CANON       , CPO         , DATEJ       ,
     4        DDRAI        , DRUN        , ET          , EXPON       ,
     5        F            , FDETC       , FDETO       , FILT        ,
     6        FLNET        , FO          , G           , GM          ,
     7        GRNCO        , GV          , HT          , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR        , K           , KJ          , KTP         ,
     A        LLDAY        , MAXDA       , MO          , MOBEG       ,
     B        NALT         , NC          , NCAN        , NCAN1       ,
     C        NDAYS        , NDRN        , NM          , NRAIN       ,
     D        NSED         , NUMDA       , PAIR        , PER         ,
     E        PERRU        , PI          , PWP         , QI          ,
     F        R1           , R2          , R3          , R4          ,
     G        R5           , RDETC       , RESIS       , RESWA       ,
     H        RLIT         , RN          , RO          , RR1         ,
     I        RRR          , RX          , SEV         , SHIEL       ,
     J        SI           , SIGMA       , SIGRN       , SIMAX
```

```
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWOV       , RCHRG       ,
     4        SMTM1(3)    , SMTM3       , TCOEF       , THSHD
      INTEGER                DREDY       , PHASE
      REAL                   ITRCP
C
C     DICTIONARY
C
C     AMSNW - THE AMOUNT OF PRECIPITATION OCCURRING AS SNOW (INCHES)
C     CLSNW - THE CONTRIBUTION OF THIS SNOW TO THE TOTAL CALORIE
C                 DEFICIT (CALORIES)
C     ITRCP - THE AMOUNT OF SNOW INTERCEPTED DURING THIS PRECIPITATION
C                 EVENT
C     TFOSN - THE TEMPERATURE FOR COMPUTING THE CONTRIBUTION OF THIS
C                 SNOW TO THE TOTAL CALORIE DEFICIT (DEGREES C)
C
C     DO NOT ALLOW ANY INTERCEPTION IN JULY AND AUGUST
C
      IF ((MO .EQ. 7) .OR. (MO .EQ. 8)) GO TO 100
C
C     DETERMINE THE AMOUNT OF INTERCEPTED SNOW AS A FUNCTION OF COVER
C      COMPOSITION AND COVER DENSITY
C
      IF (CDMAX) 100,100,110
  100 ITRCP = 0.0
      GO TO 170
  110 PRCNT = 0.125
      GRTST = 0.25
      ITRCP = AMSNW * PRCNT * (CVDEN/CDMAX)
      IF (ONTRS + ITRCP - GRTST) 160,160,150
  150 ITRCP = GRTST - ONTRS
  160 ONTRS = ONTRS + ITRCP
  170 NDYSN = 0
C
C     ADD THIS AMOUNT OF PRECIPITATION TO THE PREDICTED WATER EQUIVALENT
C
      PRWOV = PRWOV + AMSNW - ITRCP
C
C     THE SNOW FALLING WHEN THE TEMPERATURE IS BETWEEN 35 AND 32 DEGREES
C      DOES NOT ALTER THE CALORIC DEFICIT
C
      IF (TFOSN.GE.0.0) RETURN
C
C     COMPUTE THE CALORIE DEFICIT FOR THIS SNOW BY THE EQUATION
C      CALORIE DEFICIT = S(I) * DELTA T * P, WHERE
C      S(I) = SPECIFIC HEAT OF ICE (.5 CAL/CM/DEGREES C),
C      DELTA T = CHANGE IN TEMPERATURE WITH RESPECT TO FREEZING (0.0
C       DEGREES CENTIGRADE), AND
C      P = PRECIPITATION IN CM (CONVERSION FACTOR = 2.54 CM/IN),
C      THEREFORE, CALORIE DEFICIT = 0.5 * (TFOSN) * (AMSNW * 2.54)
C
      ABCDE = TFOSN * (AMSNW - ITRCP) * 1.27
      CALL CALOS (ABCDE)
      RETURN
      END
```

SUBROUTINE SNWVP

```
      SUBROUTINE SNWVP
C
C     COMPUTE THE EVAPORATION FROM THE SURFACE OF THE SNOWPACK AS A
C      FUNCTION OF THE COVER DENSITY AND REDUCE THE PACK ACCORDINGLY
C
      COMMON /ONLCR/          AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX        , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1        , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS        , PHASE       , PRWQV       , RCHRG       ,
     4        SMTM1(3)     , SMTM3       , TCDEF       , THSHD
      INTEGER                DREDY       , PHASE
      COMMON /WTRBL/          ETFRM       , EVPTR       , GENRO       ,
     1        PRCIP        , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX        , TMPMN       , WTRIN
      ETFRM = 2.0
      EVPTR = (1.0 - CVDEN) * EVPTR
      PRWQV = PRWQV - EVPTR
      RETURN
      END
```

SUBROUTINE SOIL

```
      SUBROUTINE SOIL
      COMMON /ARAYS/          ARAT(2)     , AT(2)       , CANLO(20)   ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)     , CCOVT(3)    ,
     2        DATE(5)      , DL(5)       , FC(5)       , FD1(40)     ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)      , PERSZ(11)   ,
     4        POROS(5)     , PSI(5)      , S(5)        , SAVE(5)     ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)        , THETA(5)    , TWATC(12)   , VP(5)       ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/          A1          , ADJTI       , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS         , B1          , C1          , CANCO       ,
     3        CANDF        , CANON       , CPO         , DATEJ       ,
     4        DDRAI        , DRUN        , ET          , EXPON       ,
     5        F            , FDETC       , FDETO       , FILT        ,
     6        FLNET        , FO          , G           , GM          ,
     7        GRNCO        , GV          , HT          , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR        , K           , KJ          , KTP         ,
     A        LLDAY        , MAXDA       , MD          , MDBEG       ,
     B        NALT         , NC          , NCAN        , NCAN1       ,
     C        NDAYS        , NDRN        , NM          , NRAIN       ,
     D        NSED         , NUMDA       , PAIR        , PER         ,
     E        PERRU        , PI          , PWP         , QI          ,
     F        R1           , R2          , R3          , R4          ,
     G        R5           , RDETC       , RESIS       , RESWA       ,
     H        RLIT         , RN          , RO          , RR1         ,
     I        RRR          , RX          , SEV         , SHIEL       ,
     J        SI           , SIGMA       , SIGRN       , SIMAX
      COMMON /BLOK4/          CR1         , PFC(2)      , ROOTC(2)    ,
     1        ROOTK(2)     , SNPRS
```

```
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
     1        DFGSA(51,2) , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)  , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3        PRECI(366)  , RAIN(200)   , RAINT(200)  , RELCD(51,2) ,
     4        ROLD(200)   , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5        SOLAR(366)  , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6        TEMPL(366)  , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
     7        VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
      DIMENSION             ST(20)
C
C     NUMBER OF SOIL HORIZONS:  NS = 2.
C
      NS = 2
C
C     INPUT PARAMETERS AND VARIABLES.
C
      DO 250 LP250 = 1,NS
         READ (7,290) ST
         IF (LP250 .GT. 1) GO TO 100
         READ (7,300) N,NC,RESWA,NALT1
         READ (51,310) TMAX,SCON
         GO TO 110
  100    READ (7,320) N,NC,TMAX,SCON,RESWA,NALT1
  110    IF (LP250 .EQ. 1) NALT = NALT1
         VP(LP250) = TMAX
         READ (7,330) SURTE,DENWA,VISWA,XTEMP,GRAVT
         READ (7,340) EXPOO
C
C     NOTE ORDER OF INPUT DATA.
C
         READ (7,340) (THSOI(IMPD1),IMPD1 = 1,N)
         READ (7,350) (DP(IMPD2),IMPD2 = 1,N)
         DTH = TMAX - THSOI(1)
         IF (TMAX .GE. THSOI(N)) GO TO 140
         TSOIL(1) = THSOI(1)
         DTH2 = THSOI(N) - THSOI(1)
         DO 120 LP120 = 2,N
            TSOIL(LP120) = TSOIL(LP120 - 1) + DTH * (THSOI(LP120) - THSO
     1      I(LP120 - 1))/DTH2
  120    CONTINUE
         DO 130 LP130 = 2,N
            THSOI(LP130) = TSOIL(LP130)
  130    CONTINUE
  140    IF (LP250 .NE. 1) GO TO 150
         READ (7,360) NSED
         READ (7,310) (SIZE(IMPD3),PERSZ(IMPD3),IMPD3 = 1,NSED)
C
C     CALCULATE CONVERSION FACTOR.
C
  150    ACF = 1440.0 * 30.0 * SURTE *  * 2/(VISWA * DENWA * GRAVT)
C
C     CALCULATE INCREMENT SIZE.
C
         STDIN = DTH/FLOAT (NC)
C
C     INITIALIZE TINC AND DPI ARRAYS.
C
         TINC(1) = THSOI(1)
         DPI(1) = DP(1)
         NCP1 = NC +1
C
C     CALCULATE THSOI INCREMENT LIMITS.
C
         DO 180 LP180 = 2,NCP1
            TINC(LP180) = TINC(LP180 - 1) + STDIN
C
C     CALCULATE PRESSURE INCREMENT LIMITS.
C
            DO 160 LP160 = 2,N
               KK160 = LP160
               IF (THSOI(KK160) .GE. TINC(LP180)) GO TO 170
```

```
  160       CONTINUE
  170       DPI(LP180) = ((TINC(LP180) - THSOI(KK160 - 1))/(THSOI(KK160)
     1       - THSOI(KK160 - 1))) * (DP(KK160) - DP(KK160 - 1)) + DP(KK1
     2       60 - 1)
  180    CONTINUE
C
C     ADJUST DPI TO GIVE VALUES AT MIDPOINT OF INCREMENT.
C
         DPI(NCP1) = 0.0
         DO 190 LP190 = 1,NC
            DPI(LP190) = (DPI(LP190) + DPI(LP190 + 1)) * 0.5
  190    CONTINUE
C
C     CALCULATE ADJUSTED NUMBER OF CLASSES (ANC) CORRESPONDING TO TOTAL
C     WATER CONTENT.
C
         ANC = (TMAX - 0.0)/STDIN
C
C     CALCULATE SQUARED RECIPROCAL OF 'ANC'.
C
         CLS = (1.0/ANC) *  * 2
C
C     CALCULATE PRODUCT OF COEFFICIENT AND 'HEAD' TERMS FOR EACH PORE
C     CLASS.
C
         DO 210 LP210 = 1,NC
            KK210 = NCP1 - LP210
            PCH = 0.0
            DO 200 LP200 = LP210,NC
               KK200 = NCP1 - LP200
               PCH = PCH + FLOAT (2 * (LP200 - LP210) + 1) * (1.0/DPI(KK
     1         200)) *  * 2
  200       CONTINUE
C
C     CORRECT POROSITY TERM WITH COTINC FUNCTION (CORRECTION NEEDED
C     ONLY WHEN LIMITED THSOI RANGE IS USED).
C
            COTIN = TINC(NCP1) - RESWA
C
C     CALCULATE 'K' FOR A GIVEN WATER CONTENT AND PRESSURE.
C
            CCAL(KK210) = PCH * ACF * COTIN *  * EXPOO * CLS
  210    CONTINUE
C
C     CALCULATE MATCHING FACTOR.
C
         FACTO = SCON/CCAL(NC)
C
C     ADJUST TINC AND DPI VALUES AT UPPER LIMIT OF INCREMENTS FOR
C     PLOTTING AND CALCULATE MATCHED CONDUCTIVITY AT EACH WATER
C     CONTENT.
C
         DO 220 LP220 = 1,NC
            TINC(LP220) = TINC(LP220 + 1)
            DPI(LP220) = (DPI(LP220) + DPI(LP220 + 1)) * 0.5
            CMAT(LP220) = FACTO * CCAL(LP220)
  220    CONTINUE
         DPI(NC) = 0.0
C
C     PRINT OUTPUT.
C
         WRITE (61,370) ST,SURTE,DENWA,VISWA,RESWA,XTEMP,EXPOO,GRAVT,ACF
     1   ,N,TMAX,SCON,FACTO,NC
         WRITE (61,380) (IMPD4,DPI(IMPD4),TINC(IMPD4),CCAL(IMPD4),CMAT(I
     1   MPD4),IMPD4 = 1,NC)
         WRITE (61,390) (IMPD5,THSOI(IMPD5),DP(IMPD5),IMPD5 = 1,N)
C
C     SET UP STORED DATA ARRAYS.
C
         POROS(LP250) = TINC(NC)
         DO 230 LP230 = 1,NC
            WATCO(LP230,LP250) = TINC(LP230)
            SLPOT(LP230,LP250) = DPI(LP230)
            SLCON(LP230,LP250) = CMAT(LP230)
            DEGSA(LP230,LP250) = WATCO(LP230,LP250)/POROS(LP250)
```

```
230     CONTINUE
        WETK(LP250) = CMAT(NC)/(24.0 * 60.0)
        DO 240 LP240 = 1,NC
           RELCO(LP240,LP250) = SLCON(LP240,LP250)/SLCON(NC,LP250)
240     CONTINUE
250 CONTINUE
    DO 260 LP260 = 3,5
        POROS(LP260) = POROS(LP260 - 1)
        WETK(LP260) = WETK(LP260 - 1)
260 CONTINUE
    Z1(1) = DL(1)
    DO 270 LP270 = 2,5
        Z1(LP270) = Z1(LP270 - 1) + DL(LP270)
270 CONTINUE
    CR1 = 2.0
    SNUM = ALOG(10.0) - ALOG(CR1)
    DO 280 LP280 = 1,2
        CALL TABLO (FC(LP280),PFC(LP280),ZS,LP280)
        RSFC = 1.0/ZS
        WASUB = WATCO(1,LP280)
        CALL TABLO (WASUB,PSM,ZS1,LP280)
        WATCO(1,LP280) = WASUB
        RSWP = 1.0/ZS1
        ROOTK(LP280) = SNUM/(ALOG(RSWP) - ALOG(RSFC))
        ROOTC(LP280) = CR1/(RSFC *  * ROOTK(LP280))
280 CONTINUE
    RETURN
C
C   VARIOUS FORMATS.
C
290 FORMAT (20A4)
300 FORMAT (2(I2,8X),F6.3,32X,I1)
310 FORMAT (2F10.5)
320 FORMAT (2(I2,8X),F7.4,3X,F9.5,1X,F6.3,31X,I1)
330 FORMAT (F6.2,4X,F5.3,5X,F9.6,1X,F4.1,6X,F5.1)
340 FORMAT (20F4.2)
350 FORMAT (10F6.1)
360 FORMAT (I3)
370 FORMAT (1H1,20X,20A4//20X,8HSURTEN =,F5.2,9H DENWAT =,F6.3,9H VISW
   1AT =,F8.6,9H RESWAT =,F6.3,8H XTEMP =,F4.1,2H C,//20X,10HEXPONENT
   2=,F5.2,10H GRAVITY =,F5.1,6H ACF =,E10.3//20X,3HN =,I3,7H TMAX =,F
   37.4,7H SCON =,E10.3,9H FACTOR =,E10.3,5H NC =,I5)
380 FORMAT (/21X,16HCLASS   PRESSURE,6X,5HTHETA,7X,12HCALCULATED K,6X,
   19HSAT MATCH,/23X,28H(I)   (CM WATER)    (BY VOL),7X,8H(CM/DAY),8X,
   28H(CM/DAY)/(22X,I3,4X,F7.1,8X,F5.3,2(7X,E10.3)))
390 FORMAT (/20X,31HINPUT DATA FOR THE ABOVE OUTPUT,//23X,1HJ,5X,5HTHE
   1TA,5X,8HPRESSURE,//(21X,I3,5X,F6.3,4X,F7.1)/)
    END
```

SUBROUTINE SOLVO

```
      SUBROUTINE SOLVO
C
C     THIS PROGRAM UNIT SOLVES FOR THE ROOTS OF A NONLINEAR EQUATION
C     USING A LINEAR FRACTIONAL ITERATION.  WESTLEY,G.W. AND J.A.WATTS
C     THE COMPUTING TECHNOLOGY CENTER NUMERICAL ANALYSIS LIBRARY,
C     CTC-39.
C
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANDF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
```

```
8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
9        JSTAR       , K           , KJ          , KTP         ,
A        LLDAY       , MAXDA       , MD          , MORE6       ,
B        NALT        , NC          , NCAN        , NCAN1       ,
C        NDAYS       , NDRN        , NM          , NKAIN       ,
D        NSED        , NUMDA       , PAIR        , PER         ,
E        PERRU       , PI          , PWP         , QI          ,
F        R1          , R2          , R3          , R4          ,
G        R5          , RDETC       , RESIS       , RESWA       ,
H        RLIT        , RN          , RO          , RR1         ,
I        RRR         , RX          , SEV         , SHIEL       ,
J        SI          , SIGMA       , SIGRN       , SIMAX
 COMMON /BLOK2/        SIMIN       , SLAT        , STIME       ,
1        SUN1        , SUN2        , TEMP1       , TEMP2       ,
2        TOIVO       , TP          , TPRES       , TRCAN       ,
3        V           , XL          , XN          , Z
 DIMENSION             FX(30)      , X(30)
 ABCIS (X3,X2,X1,Y3,Y2,Y1) = X3 + ((Y1 * Y3 - Y2 * Y3) * (X3 - X1)
1* (X2 - X3))/(Y1 * Y2 * (X1 - X2) + Y1 * Y3 * (X3 - X1) + Y2 * Y3
2* (X2 - X3))
 X(1) = Z
 CALL EVAL (X(1),FX(1))
 IF (FX(1) .LT. 0.0) GO TO 110
100 X(2) = X(1)
 FX(2) = FX(1)
 X(1) = X(2) + 200.0
 CALL EVAL (X(1),FX(1))
 IF ((FX(1) .LT. 0.0) .AND. (FX(2) .GE. 0.0)) GO TO 120
 GO TO 100
110 X(2) = X(1) - 200.0
 CALL EVAL (X(2),FX(2))
 IF ((FX(1) .LT. 0.0) .AND. (FX(2) .GE. 0.0)) GO TO 120
 X(1) = X(2)
 FX(1) = FX(2)
 GO TO 110
120 X(3) = (X(1) + X(2))/2.0
 CALL EVAL (X(3),FX(3))
 DO 130 LP130 = 4,30
    II130 = LP130
    X(LP130) = ABCIS (X(LP130 - 1),X(LP130 - 2),X(LP130 - 3),FX(LP1
  1 30 - 1),FX(LP130 - 2),FX(LP130 - 3))
    CALL EVAL (X(LP130),FX(LP130))
    IF (ABS (FX(LP130)) .LE. 1.0E - 5) GO TO 140
130 CONTINUE
 WRITE (6,150)
 CALL EXIT
140 PWP = X(II130)
 Z = PWP
 RETURN
150 FORMAT (20X,47HFRACTIONAL ITERATION IN SOLVO DID NOT CONVERGE.)
 END
```

SUBROUTINE SUCT (INDEX)

```
      SUBROUTINE SUCT (INDEX)
C
C     THIS PROGRAM UNIT DETERMINES THE AVERAGE SUCTION BY MEIN AND
C     LARSONS.
C
      COMMON /ARAYS/        ARAI(2)     , AT(2)       , CANLO(20)   ,
     1        CANLI(20)   , CASEI(20)   , CCOV(3)     , CCOVT(3)    ,
     2        DATE(5)     , DL(5)       , FC(5)       , FD1(40)     ,
```

```
     3        LASTD(12)   , NFIRS(12)   , NR(40)      , PERSZ(11)   ,
     4        POROS(5)    , PSI(5)      , S(5)        , SAVE(5)     ,
     5        SINIT(5)    , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)       , THETA(5)    , TWATC(12)   , VP(5)       ,
     7        WETK(5)     , Z1(5)
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DORAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
     D        NSED        , NUMDA       , PAIR        , PER         ,
     E        PERRU       , PI          , PWP         , QI          ,
     F        R1          , R2          , R3          , R4          ,
     G        R5          , RDETC       , RESIS       , RESWA       ,
     H        RLIT        , RN          , RO          , RR1         ,
     I        RRR         , RX          , SEV         , SHIEL       ,
     J        SI          , SIGMA       , SIGRN       , SIMAX
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
     1        DEGSA(51,2) , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)  , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3        PRECI(366)  , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4        ROLD(200)   , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5        SOLAR(366)  , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6        TEMPL(366)  , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
     7        VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
      SAVE(INDEX) = 0.0
      IF (DEGSA(NC,1) .LE. SINIT(INDEX)) GO TO 130
      DO 100 LP100 = 2,NC
         KK100 = NC - LP100 + 1
         MM100 = KK100 + 1
         IF (DEGSA(KK100,1) .GE. SINIT(INDEX)) GO TO 100
         AA = (SINIT(INDEX) - DEGSA(MM100,1))/(DEGSA(KK100,1) - DEGSA(MM
     1   100,1))
         RKLOW = RELCO(MM100,1) + (RELCO(KK100,1) - RELCO(MM100,1)) * AA
         SCLOW = SLPOT(MM100,1) + (SLPOT(KK100,1) - SLPOT(MM100,1)) * AA
         DELOW = (RELCO(NC,1) - RKLOW) * 2.0
         SAVE(INDEX) = (SCLOW + SLPOT(MM100,1)) * (RELCO(MM100,1) - RKLO
     1   W)/DELOW
         GO TO 110
  100 CONTINUE
      MM100 = 1
  110 IF (MM100 .GE. NC) GO TO 130
      NSUCT = NC - 1
      DO 120 LP120 = MM100,NSUCT
         SAVE(INDEX) = SAVE(INDEX) - (SLPOT(LP120,1) + SLPOT(LP120 + 1,1
     1   )) * (RELCO(LP120,1) - RELCO(LP120 + 1,1))/DELOW
  120 CONTINUE
  130 CONTINUE
      RETURN
      END
```

SUBROUTINE TABLO (CHETA, PSM, ZS, J)

```
      SUBROUTINE TABLO (CHETA,PSM,ZS,J)
C
C     METHOD OF TABLE LOOKUP FOR MATRIC WATER POTENTIAL (PSM) AND
C     CONDUCTIVITY (ZS) FROM SOIL WATER CONTENT (CHETA). THE FOLLOWING
C     TABLES ARE CALCULATED IN THE PROGRAM UNIT SOIL:
C
C        WATCO = THE TABLE OF WATER CONDUCTIVITIES.
C        SLPOT = THE TABLE OF MATRIC WATER POTENTIALS.
C        SLCON = THE TABLE OF CONDUCTIVITIES.
C
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDFTO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
     D        NSED        , NUMDA       , PAIR        , PER         ,
     E        PERRU       , PI          , PWP         , QI          ,
     F        R1          , R2          , R3          , R4          ,
     G        R5          , RDETC       , RESIS       , RESWA       ,
     H        RLIT        , RN          , RO          , RR1         ,
     I        RRR         , RX          , SEV         , SHIEL       ,
     J        SI          , SIGMA       , SIGRN       , SIMAX
      COMMON /EMBLK/        CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
     1        DEGSA(51,2) , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)  , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3        PRECI(366)  , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4        ROLD(200)   , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5        SOLAR(366)  , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6        TEMPL(366)  , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
     7        VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
C
C     VALUES AT DRY END OUTSIDE TABLE RANGE.
C
      Y1 = RESWA
      Y2 = 15000.0
      Y3 = 0.0
      DO 100 LP100 = 1,NC
         IF (CHETA .GT. WATCO(LP100,J)) GO TO 100
         IF (LP100 .LE. 1) GO TO 110
C
C     VALUES WITHIN TABLE RANGE.
C
         Y1 = WATCO(LP100 - 1,J)
         Y2 = SLPOT(LP100 - 1,J)
         Y3 = SLCON(LP100 - 1,J)
  110    PROPT = (WATCO(LP100,J) - CHETA)/(WATCO(LP100,J) - Y1)
         PSM = SLPOT(LP100,J) - (SLPOT(LP100,J) - Y2) * PROPT
         ZS = SLCON(LP100,J) - (SLCON(LP100,J) - Y3) * PROPT
         GO TO 120
  100 CONTINUE
C
C     VALUES AT SATURATION.
C
      CHETA = WATCO(NC,J)
      PSM = SLPOT(NC,J)
      ZS = SLCON(NC,J)
  120 CONTINUE
      RETURN
      END
```

SUBROUTINE TEWAT

```
      SUBROUTINE TEWAT
      COMMON /ARAYS/        ARAT(2)      , AT(2)       , CANLO(20)   ,
     1        CANLI(20)    , CASEI(20)   , CCOV(3)     , CCOVT(3)    ,
     2        DATE(5)      , DL(5)       , FC(5)       , FO1(40)     ,
     3        LASTD(12)    , NFIRS(12)   , NR(40)      , PERSZ(11)   ,
     4        POROS(5)     , PSI(5)      , S(5)        , SAVE(5)     ,
     5        SINIT(5)     , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)        , THETA(5)    , TWATC(12)   , VP(5)       ,
     7        WETK(5)      , Z1(5)
      COMMON /BLOCK/        A1           , ADJTI       , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS         , B1          , C1          , CANCO       ,
     3        CANOF        , CANON       , CPO         , DATEJ       ,
     4        DDRAI        , DRUN        , ET          , EXPON       ,
     5        F            , FDETC       , FDETO       , FILT        ,
     6        FLNET        , FO          , G           , GM          ,
     7        GRNCO        , GV          , HT          , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR        , K           , KJ          , KTP         ,
     A        LLDAY        , MAXDA       , MO          , MOBEG       ,
     B        NALT         , NC          , NCAN        , NCAN1       ,
     C        NDAYS        , NDRN        , NM          , NRAIN       ,
     D        NSED         , NUMDA       , PAIR        , PER         ,
     E        PERRU        , PI          , PWP         , QI          ,
     F        R1           , R2          , R3          , R4          ,
     G        R5           , RDETC       , RESIS       , RESWA       ,
     H        RLIT         , RN          , RO          , RR1         ,
     I        RRR          , RX          , SEV         , SHIEL       ,
     J        SI           , SIGMA       , SIGRN       , SIMAX
      COMMON /EMBLK/        CCAL(51)     , CMAT(51)    , CUMEX(300)  ,
     1        DEGSA(51,2)  , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)   , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
     3        PRECI(366)   , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4        ROLD(200)    , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5        SOLAR(366)   , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6        TEMPL(366)   , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
     7        VAPOR(366)   , VOL1(5,40)  , WATCO(51,2)
      NSTRT = 1
      NEND = 0
      DO 110 LP110 = 1,NM
         KK110 = MOBEG + LP110 - 1
         IF (KK110 .GT. 12) KK110 = KK110 - 12
         TEMPT = 0.0
         NEND = NEND + LASTD(KK110)
         DO 100 LP100 = NSTRT,NEND
            TEMPT = TEMPT + TEMP(LP100)
100      CONTINUE
         TEMPT = TEMPT/FLOAT (LASTD(KK110))
         TWATC(KK110) = 0.96875 * TEMPT - 20.3125/9.0
         NSTRT = NSTRT + LASTD(KK110)
110   CONTINUE
      RETURN
      END
```

SUBROUTINE VOLOU

```
      SUBROUTINE VOLOU
      COMMON /BLOCK/        A1           , ADJTI       , ALBGR       ,
     1        ALBVE        , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS         , B1          , C1          , CANCO       ,
     3        CANOF        , CANON       , CPO         , DATEJ       ,
     4        DDRAI        , DRUN        , ET          , EXPON       ,
     5        F            , FDETC       , FDETO       , FILT        ,
     6        FLNET        , FO          , G           , GM          ,
     7        GRNCO        , GV          , HT          , IPLAN       ,
     8        ISTOR        , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR        , K           , KJ          , KTP         ,
     A        LLDAY        , MAXDA       , MO          , MOBEG       ,
     B        NALT         , NC          , NCAN        , NCAN1       ,
```

```
C       NDAYS       , NDRN        , NM          , NRAIN       ,
D       NSED        , NUMDA       , PAIR        , PER         ,
E       PERRU       , PI          , PWP         , QI          ,
F       R1          , R2          , R3          , R4          ,
G       R5          , RDETC       , RESIS       , RESWA       ,
H       RLIT        , RN          , RO          , RR1         ,
I       RRR         , RX          , SEV         , SHIEL       ,
J       SI          , SIGMA       , SIGRN       , SIMAX
 COMMON /BLOK2/       SIMIN       , SLAT        , STIME       ,
1       SUN1        , SUN2        , TEMP1       , TEMP2       ,
2       TOTVO       , TP          , TPRES       , TRCAN       ,
3       V           , XL          , XN          , Z
 COMMON /BLOK4/       CR1         , PFC(2)      , ROOTC(2)    ,
1       ROOTK(2)    , SNPRS
 IF (JJJ .NE. 1) GO TO 100
 IF (NALT .EQ. 1) WRITE (54) DATEJ,SNPRS
 IF (NALT .EQ. 2) WRITE (55) DATEJ,SNPRS
 IF (NALT .EQ. 3) WRITE (56) DATEJ,SNPRS
 IF (NALT .EQ. 4) WRITE (57) DATEJ,SNPRS
100 INOUT = IFIX (DATEJ)
 WRITE (15) INOUT,TOTVO,FO
 RETURN
 END
```

SUBROUTINE VOLUM

```
 SUBROUTINE VOLUM
 COMMON /BLOCK/       A1          , ADJTI       , ALBGR       ,
1       ALBVE       , ALEAF       , ALMAX       , ALSR        ,
2       ALSS        , K1          , C1          , CANCO       ,
3       CANOF       , CANON       , CPO         , DATEJ       ,
4       DDRAI       , DRUN        , ET          , EXPON       ,
5       F           , FDETC       , FDETO       , FILT        ,
6       FLWET       , FO          , G           , GM          ,
7       GRNCO       , GV          , HT          , IPLAN       ,
8       ISTOR       , ITIME       , JJJ         , JPLAN       ,
9       JSTAR       , K           , KJ          , KTP         ,
A       LLDAY       , MAXDA       , MO          , MOBEG       ,
B       NALT        , NC          , NCAN        , NCAN1       ,
C       NDAYS       , NDRN        , NM          , NRAIN       ,
D       NSED        , NUMDA       , PAIR        , PER         ,
E       PERRU       , PI          , PWP         , QI          ,
F       R1          , R2          , R3          , R4          ,
G       R5          , RDETC       , RESIS       , RESWA       ,
H       RLIT        , RN          , RO          , RR1         ,
I       RRR         , RX          , SEV         , SHIEL       ,
J       SI          , SIGMA       , SIGRN       , SIMAX
 COMMON /BLOK2/       SIMIN       , SLAT        , STIME       ,
1       SUN1        , SUN2        , TEMP1       , TEMP2       ,
2       TOTVO       , TP          , TPRES       , TRCAN       ,
3       V           , XL          , XN          , Z
 COMMON /EMBLK/       CCAL(51)    , CMAT(51)    , CUMEX(300)  ,
1       DEGSA(51,2) , DP(51)      , DPI(51)     , EX(300)     ,
2       EXNEW(200)  , EXTIM(300)  , EXTNE(200)  , MULTD(366)  ,
3       PRECI(366)  , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
4       ROLD(200)   , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
5       SOLAR(366)  , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
6       TEMPL(366)  , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
7       VAPOR(366)  , VOL1(5,40)  , WATCO(51,2)
C
C     THIS LOOP COUNTS THE NUMBER OF DAYS THE STORM LASTS.
C
```

```
      NDAYS = 1
      DO 100 LP100 = 1,366
         KK100 = ITIME + LP100 - 1
         IF (KK100 .GT. MAXDA) GO TO 110
         IF (MULTD(KK100) .EQ. 0) GO TO 110
         NDAYS = NDAYS + 1
  100 CONTINUE
C
C     CALL THE RAIN INPUT ROUTINE.
C
  110 CALL IN
C
C     CALL THE INTERCEPTION ROUTINE.
C
      CALL INTRC
C
C    INITIALIZE MULTIPLE DAY STORM VARIABLES.
C
      DO 130 LP130 = 1,NDAYS
         DO 120 LP120 = 1,5
            VOL1(LP120,LP130) = 0.0
  120    CONTINUE
  130 CONTINUE
C
C     CALL THE INFILTRATION ROUTINE.
C
      CALL LAYIN
      IF (TOTVO .LE. 0.0) GO TO 160
      IF (ADJTI .LE. 0.0) GO TO 150
      DO 140 LP140 = 1,K
         EXTIM(LP140) = EXTIM(LP140) + ADJTI
  140 CONTINUE
      TP = TP + ADJTI
  150 ISTOR = ISTOR + 1
      CALL EXCOU
      CALL RUNOU
  160 CONTINUE
      RETURN
      END
```

SUBROUTINE WATBL (F9, F10, F11)

```
      SUBROUTINE WATBL (F9,F10,F11)
C
C     THIS PROGRAM UNIT IS THE MAIN ROUTINE OF THE WATER BALANCE MODEL.
C     IT RECEIVES THE DRIVING, STATIC AND CONTINUOUS VARIABLES FROM
C     THE OPERATING ROUTINES, CONTROLS THE COMPUTATIONS ON THEM, AND
C     RETURNS THE NEW VALUES FOR THE CONTINUOUS VARIABLES AND THE
C     RESULTS OF THIS DAY.  SEE THE REPLACEMENT STATEMENTS BELOW
C     FOR THE VARIABLE DEFINITIONS OF THE PARAMETERS
C
C     DICTIONARY OF WATER BALANCE COMMON BLOCKS
C
C     AVTMC - THE MEAN TEMPERATURE FOR THE DAY IN DEGREES C
C     BSTMF - BASE TEMPERATURE DEGREES FARENHEIT, RAIN TURNS TO SNOW
C     CALDF - THE CALORIE DEFICIT IS THE NUMBER OF CALORIES NEEDED
C                 TO BRING THE SNOWPACK TEMPERATURE TO ZERO DEGREES
C                 CENTIGRADE (NOTE SHOULD BE MADE THAT IT IS A POSITIVE
C                 QUANTITY)
C     CVDEN - THE COVER DENSITY IS THE FRACTION OF THE GROUND OR SNOW
C                 SURFACE SHADED FROM DIRECT SUNLIGHT OR RADIATION
```

```
C     DREDY = 0, DIFFUSION MODEL (PROGRAM UNIT DIFMD) NOT INITIALIZED
C           = 1, DIFFUSION MODEL INITIALIZED AND READY FOR SNOWPACK
C                TEMPERATURE SIMULATION
C           = -1, DIFFUSION MODEL MAY NOT BE USED
C     ENGBL - THE TOTAL CALORIC INPUT TO OR LOSS FROM THE SNOWPACK
C                DURING A DAY.  IT IS THE ALGEBRAIC SUM OF THE
C                ENERGY INVOLVED WITH THE PRECIPITATION AND THAT OF
C                THE RADIATION BALANCE
C     ENBL1 - THE VALUE OF - ENGBL - AT THE END OF THE LAST DAY
C     ETFRM = 1, EVAPORATION IS FROM THE CANOPY
C           = 2, EVAPORATION IS FROM THE SURFACE OF THE SNOWPACK
C           = 4, EVAPOTRANSPIRATION IS FROM SNOWMELT, RAIN OR THE
C                SOIL MANTLE STORAGE
C     EVPTR - WHEN FIRST RECEIVED, THIS VARIABLE IS THE POTENTIAL
C                EVAPOTRANSPIRATION AS COMPUTED BY THE HAMON METHOD
C                AND ADJUSTED FOR AVAILABLE RADIATION.  AFTER ACTION
C                IS TAKEN BY THE WATER BALANCE ROUTINES, THE ORIGINAL
C                VALUE HAS BEEN ADJUSTED FURTHER BY THE METHODS
C                DISCUSSED IN PROGRAM UNITS CANVP, EVTRN, AND SNWVP.
C                IT THEN REPRESENTS THE EVAPOTRANSPIRATION DURING THIS
C                DAY
C     FREWT - THE FREE WATER BEING HELD BY THE SNOWPACK
C     LSTUS - AN INDICATOR USED IN FUNCTION PCKRF TO DETERMINE
C                WHICH REFLECTIVITY FUNCTION TO USE
C     NDYSN - THE NUMBER OF DAYS SINCE NEW SNOW HAS FALLEN
C     ONTRS - THE VOLUME OF INTERCEPTED SNOW REMAINING ON THE CANOPY
C     PHASE = -1, THE SNOWPACK HAS BARELY ACCUMULATED TO THE POINT WHERE
C                THE DIFFUSION MODEL IS STABLE AND MAY BE USED TO
C                CONTROL THE SNOWPACK TEMPERATURE
C           = 0, THE SNOWPACK IS ACCUMULATING AND HAS NOT YET REACHED
C                A DEPTH WHICH WILL PROVIDE STABILITY FOR THE
C                DIFFUSION MODEL
C           = 1, THE SNOWPACK HAS REACHED A SUFFICIENT DEPTH TO ALLOW
C                THE DIFFUSION MODEL TO CONTROL THE PACK TEMPERATURE
C                UNTIL THE MELT SEASON, WHEN THE RADIATION ROUTINES
C                RESUME CONTROL TO GOVERN THE MELT PHASE
C     PRCIP - OBSERVED PRECIPITATION IN INCHES
C     PRWQV - PREDICTED WATER EQUIVALENT OF THE SNOWPACK IN INCHES
C     RADIN - RADIATION IN IS THE TOTAL INCIDENT SHORT WAVE RADIATION
C     RDLWN - NET LONG  WAVE RADIATION IS THE ALGEBRAIC SUM OF THE LONG
C                WAVE RADIATION FROM THE FOREST AND THE LONG WAVE
C                RADIATION LOST BY THE SNOWPACK TO THE CANOPY
C     RDSWN - THE CALORIC INPUT TO THE PACK BY THE NET SHORT WAVE
C                RADIATION
C     RCHRG - THE RECHARGE REQUIREMENTS, OR SOIL MANTLE STORAGE DEFICIT
C     SMTM1 - AN ARRAY USED PRIMARILY IN PROGRAM UNIT DIFMD IN THE
C                SIMULATION OF THE AVERAGE SNOWPACK TEMPERATURE.
C                TO INSURE STABILITY OF THE DIFFUSION MODEL, THE
C                DAY IS PARTITIONED INTO 12 HOUR INTERVALS, AS
C                DISCUSSED IN PROGRAM UNIT DIFMD.  THIS ARRAY STORES
C                THE CONDITIONS PRESENT DURING THIS INTERVAL FOR USE
C                IN THE SIMULATION ON THE NEXT INTERVAL.  LOCATION 1
C                STORES THE AVERAGE AIR TEMPERATURE (ASSUMED TO BE
C                THE SURFACE TEMPERATURE OF THE SNOWPACK), LOCATION 2
C                IS THE SNOWPACK TEMPERATURE AT A NODE MIDWAY
C                BETWEEN THE SURFACE AND THE GROUND, AND LOCATION 3 IS
C                THE GROUND TEMPERATURE.
C     TCOEF - THE TRANSMISIVITY COEFFICIENT USED TO ESTIMATE THE NET
C                SHORT WAVE RADIATION REACHING THE SNOWPACK.  SEE
C                REIFSNYDER AND LULL, RADIANT ENERGY IN RELATION TO
C                FORESTS, USFS TECH. BUL 1344, 1965.
C     TMPMX - THE MAXIMUM TEMPERATURE DURING THE DAY IN DEGREES
C                FARENHEIT
C     TMPMN - THE MINIMUM TEMPERATURE DURING THE DAY IN DEGREES
C                FARENHEIT
C     THSHD - THE THRESHOLD TEMPERATURE FOR DETERMINING WHETHER OR NOT
C                TO RE-INITIALIZE THE REFLECTIVITY FUNCTION WHEN
C                THERE IS A SNOW EVENT.  IF THE MAXIMUM TEMPERATURE IS
C                GREATER THAN THE THRESHOLD VALUE DO NOT RE-INITIALIZE
C                THE FUNCTION REGARDLESS OF THE PRECIPITATION
C     WTRIN - THE SUM OF ANY SNOWMELT AND ANY RAIN WHICH PROVIDES
C                DIRECT INPUT TO THE WATER BALANCE
C
```


Reproduced from best available copy.

```
      COMMON /ONLCR/        AVTMC       , BSTMF       , CALDF       ,
     1        CDMAX       , CVDEN       , DREDY       , ENGBL       ,
     2        ENBL1       , FREWT       , LSTUS       , NDYSN       ,
     3        ONTRS       , PHASE       , PRWOV       , RCHRG       ,
     4        SMTM1(3)    , SMTM3       , TCOFF       , THSHD
      INTEGER                DREDY       , PHASE
      COMMON /WTRBL/        ETFRM       , EVPTR       , GENRO       ,
     1        PRCIP       , RADIN       , RDLWN       , RDSWN       ,
     2        TMPMX       , TMPMN       , WTRIN
C
C     OBTAIN THE STATION DESCRIPTORS
C     RECALL THE CONTINUOUS VARIABLES NECESSARY FOR THE OPERATION OF THE
C      MODEL DURING THIS DAY
C
      NDYSN = NDYSN + 1
      IF (DREDY) 110,110,100
  100 SMTM1(1) = F9
      SMTM1(2) = F10
      SMTM1(3) = F11
C
C     AVTMC = (((TMPMX - 32) + (TMPMN - 32))/2) * (5/9)
C
  110 AVTMC = (TMPMX + TMPMN - 64.0) * 5.0/18.0
C
C     START THE ENERGY BALANCE AND THE INPUT AT ZERO FOR THIS DAY
C
      ENGBL = 0.0
      WTRIN = 0.0
C
C     IF THERE IS NO PRECIPITATION, THERE IS NO NEED TO PASS THROUGH
C      THE CLASSIFICATION STATEMENTS
C
      IF (PRCIP) 180,180,120
C
C     SEE IF THE PRECIPITATION IS ALL SNOW
C
  120 IF ((TMPMN.LE.32.0).OR.(TMPMX.LT.BSTMF)) GO TO 170
C
C     SEE IF ANY OF IT IS SNOW
C
      IF (TMPMN - BSTMF) 130,140,140
  130 CALL MXTRE
      GO TO 180
C
C     THIS IS A RAIN EVENT.  IF THERE IS NO PACK, THE RAIN IS DIRECT
C      INPUT TO THE WATER BALANCE.  BUT IF THERE IS A PACK, DETERMINE
C      THE EFFECTS OF THE RAIN
C
  140 IF (PRWOV) 150,150,160
  150 WTRIN = PRCIP
      GO TO 250
  160 CALL RASNO (AVTMC,PRCIP)
      GO TO 180
C
C     THIS IS A SNOW EVENT
C
  170 ABCDE = AMIN1(AVTMC,0.0)
      CALL SNOWD (ABCDE,PRCIP)
C
C     IF THERE IS SNOW ON THE TREES, EVAPORATE ONLY FROM THE CANOPY
C
  180 IF (ONTRS) 220,220,190
  190 CALL CANVP
C
C     ON THE FIRST DAY AFTER FRESH SNOW, ASSUME TURBULENCE HAS REMOVED
C      ANY REMAINING INTERCEPTED SNOW AND ADDED IT TO THE PACK
C
      IF (NDYSN - 1) 210,200,200
  200 PRWOV = PRWOV + ONTRS
      ONTRS = 0.0
```

```
C
C     IF THERE IS NO SNOWPACK, BYPASS THE RADIATION ROUTINES
C
  210 IF (PRWQV) 280,280,270
C
C     DETERMINE WHETHER TO SATISFY THE EVAPOTRANSPIRATION REQUIREMENTS
C      UNDER GROWING SEASON OR WINTER CONDITIONS
C
  220 IF (PRWQV) 250,250,230
  230 IF (PRWQV - 5.0) 240,240,260
C
C     USE THE GROWING SEASON ROUTINES TO INCLUDE TRANSPIRATION
C
  240 CALL RADBL
C
C     ADD - WTRIN - TO THE RECHARGE REQUIREMENTS SO THE ET ROUTINE CAN
C      OPERATE ON THE INPUT AS WELL AS THE STORAGE
C
  250 RCHRG = RCHRG + WTRIN
      CALL EVTRN
      GO TO 290
C
C     USE THE WINTER ROUTINES TO EVAPORATE FROM THE SNOWPACK SURFACE
C
  260 CALL SNWVP
  270 CALL RADBL
C
C     ADD - WTRIN - TO THE RECHARGE REQUIREMENTS
C
  280 RCHRG = RCHRG + WTRIN
C
C     IF THE RECHARGE REQUIREMENTS WERE SATISFIED, THE EXCESS IS
C      CONSIDERED TO BE GENERATED RUNOFF
C
  290 IF (RCHRG) 310,310,300
  300 GENRO = RCHRG
      RCHRG = 0.0
      GO TO 320
  310 GENRO = 0.0
  320 ENBL1 = ENGBL
C
C     WHEN THE PACK IS GONE, RESET THE PHASE INDICATOR
C
      IF (PRWQV) 330,330,340
  330 PHASE = 0
      RETURN

  340 IF (DREDY) 360,360,350
  350 F9 = SMTM1(1)
      F10 = SMTM1(2)
      F11 = SMTM1(3)
  360 RETURN
      END
```

SUBROUTINE WSMOU

```
      SUBROUTINE WSMOU
      COMMON /BLOCK/        A1          , ADJTI       , ALBGR       ,
     1        ALBVE       , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS        , B1          , C1          , CANCO       ,
     3        CANOF       , CANON       , CPO         , DATEJ       ,
     4        DDRAI       , DRUN        , ET          , EXPON       ,
     5        F           , FDETC       , FDETO       , FILT        ,
     6        FLNET       , FO          , G           , GM          ,
     7        GRNCO       , GV          , HT          , IPLAN       ,
     8        ISTOR       , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR       , K           , KJ          , KTP         ,
     A        LLDAY       , MAXDA       , MO          , MOBEG       ,
     B        NALT        , NC          , NCAN        , NCAN1       ,
     C        NDAYS       , NDRN        , NM          , NRAIN       ,
```

```
      D        NSED        , NUMDA       , PAIR        , PER         ,
      E        PERRU       , PI          , PWP         , QI          ,
      F        R1          , R2          , R3          , R4          ,
      G        R5          , RDETC       , RESIS       , RESWA       ,
      H        RLIT        , RN          , RO          , RR1         ,
      I        RRR         , RX          , SEV         , SHIEL       ,
      J        SI          , SIGMA       , SIGRN       , SIMAX
      WRITE (10,100) PERRU
      RETURN
C
C     VARIOUS FORMATS.
C
  100 FORMAT (2X,G30.10)
      END
```

SUBROUTINE ZEROU

```
      SUBROUTINE ZEROU
C
C     THIS PROGRAM UNIT DETERMINES THE FINAL STORM NUMBERS ON THE
C     WHOLE WATERSHED AND RENUMBERS THE STORM NUMBERS ON THE FILES
C     EX1XXX,RAOXX,RUNXXX,AND TUNXXX.
C
      COMMON /ARAYS/        ARAT(2)       , AT(2)       , CANLO(20)   ,
     1        CANLI(20)     , CASEI(20)   , CCOU(3)     , CCOUT(3)    ,
     2        DATE(5)       , DL(5)       , EC(5)       , EO1(40)     ,
     3        LASTD(12)     , MFIRS(12)   , NR(40)      , PERSZ(11)   ,
     4        POROS(5)      , PSI(5)      , S(5)        , SAME(5)     ,
     5        SINIT(5)      , SIZE(11)    , SLLGT(3)    , SLOPE(3)    ,
     6        SW(5)         , THETA(5)    , TWATC(12)   , UP(5)       ,
     7        WETK(5)       , Z1(5)
      COMMON /BLOCK/        A1            , ADITI       , ALBGR       ,
     1        ALBVE         , ALEAF       , ALMAX       , ALSR        ,
     2        ALSS          , B1          , C1          , CANCO       ,
     3        CANOF         , CANON       , CPO         , DATE1       ,
     4        DDRAI         , DRIN        , ET          , EXPON       ,
     5        F             , FDETC       , FDETO       , FILT        ,
     6        FLNET         , FO          , G           , GM          ,
     7        GRNCO         , GU          , HT          , IPLAN       ,
     8        ISTOR         , ITIME       , JJJ         , JPLAN       ,
     9        JSTAR         , K           , KJ          , KTP         ,
     A        LLDAY         , MAXDA       , MO          , MOREG       ,
     B        MALT          , NC          , NCAN        , NCAN1       ,
     C        NDAYS         , NDRN        , NH          , NRATN       ,
     D        NSED          , NUMDA       , PAIR        , PER         ,
     E        PERRU         , PI          , PWP         , QI          ,
     F        R1            , R2          , R3          , R4          ,
     G        R5            , RDETC       , RESIS       , RESWA       ,
     H        RLIT          , RN          , RO          , RR1         ,
     I        RRR           , RX          , SEV         , SHIEL       ,
     J        SI            , SIGMA       , SIGRN       , SIMAX
      COMMON /EMBLK/        CCAL(51)      , CMAT(51)    , CUMEX(300)  ,
     1        DEGSA(51,2)   , DP(51)      , DPI(51)     , EX(300)     ,
     2        EXNEW(200)    , EXTIN(300)  , EXTNE(200)  , HULTD(366)  ,
     3        PRECI(366)    , RAIN(200)   , RAINT(200)  , RELCO(51,2) ,
     4        ROLD(200)     , RTOLD(200)  , SLCON(51,2) , SLPOT(51,2) ,
     5        SOLAR(366)    , SPCH(51)    , TEMP(366)   , TEMPH(366)  ,
     6        TEMPL(366)    , THSOI(51)   , TINC(51)    , TSOIL(51)   ,
     7        VAPOR(366)    , VOL1(5,40)  , WATCO(51,2)
      COMMON /ZBLOK/        NOPL
      DIMENSION             NSTPL(50)     , NSTRM(366)  , NUMST(366)  ,
     1        ISDAY(50,366)
C
C     REWIND FILES.
C
      REWIND 8
      REWIND 14
```

Reproduced from best available copy.

```
      REWIND 11
      REWIND 21
C
C     INITIALIZE THE NUMBER OF STORMS ON A GIVEN SIMULATION DAY
C     (NSTRM) , THE CORRESPONDENCE ARRAY (ISDAY) , THE STORM NUMBER
C     FOR THE SIMULATION DAY (NUMST) , AND THE NUMBER OF STORMS WHICH
C     OCCURRED ON A GIVEN PLANE (NSTPL).
C
      DO 110 LP110 = 1,MAXDA
         NSTRM(LP110) = 0
         NUMST(LP110) = 0
         DO 100 LP100 = 1,NOPL
            ISDAY(LP100,LP110) = 0
  100    CONTINUE
  110 CONTINUE
      DO 120 LP120 = 1,NOPL
         NSTPL(LP120) = 0
  120 CONTINUE
C
C     CALCULATE THE JULIAN DATE OF DECEMBER 31.
C
      NDSYR = NFIRS(12) + 30
C
C     INPUT THE CORRESPONDENCE BETWEEN STORM, PLANE, AND THE
C     SIMULATION TIME.
C
  130 READ (21) INOU1,INOU3,INOU4,RDUM1,RDUM2,RDUM3
      IF (EOF(21) .NE. 0.0) GO TO 140
      ISDAY(INOU1,INOU3) = INOU4
      NSTRM(INOU4) = NSTRM(INOU4) + 1
      NSTPL(INOU1) = NSTPL(INOU1) + 1
      GO TO 130
  140 REWIND 21
C
C     CALCULATE THE WATERSHED STORM NUMBER FOR EACH OF THE SIMULATION
C     DAYS WHICH HAVE AT LEAST ONE STORM EVENT ON ANY PLANE.
C
      NSTMS = 0
      DO 150 LP150 = 1,MAXDA
         IF (NSTRM(LP150) .LE. 0) GO TO 150
         NSTMS = NSTMS + 1
         NUMST(LP150) = NSTMS
         IF (NSTRM(LP150) .LE. NOPL) GO TO 150
         WRITE (6,260) LP150
         CALL EXIT
  150 CONTINUE
C
C     FIND OUT HOW MANY PLANES HAD ALL OF THE STORMS.  IF ALL PLANES
C     ARE OK, GO BACK TO THE MAIN PROGRAM, AFTER REWRITING TUMYYY.
C
      NOK = 0
      DO 160 LP160 = 1,NOPL
         IF (NSTPL(LP160) .GE. NSTMS) NOK = NOK + 1
  160 CONTINUE
      NBGIN = 1
      IF (NOK .GE. NOPL) NBGIN = 4
C
C     CHANGE PLANE STORM NUMBERS TO THE TOTAL WATERSHED STORM NUMBER
C     ON EACH OF THE FILES: EX1YYY,RADYYY,RUNYYY,AND TUMYYY.
C
      DO 200 LP200 = NBGIN,4
         REWIND 94
         IF (LP200 .EQ. 1) NTAPE = 8
         IF (LP200 .EQ. 2) NTAPE = 14
         IF (LP200 .EQ. 3) NTAPE = 11
         IF (LP200 .EQ. 4) NTAPE = 21
C
C     INPUT DATA FROM OLD FILES AND STORE TEMPORARIALLY IN DUMMY FILE.
C
  170    IF (LP200 .EQ. 1) READ (8) JJJ,ISTOR,NUMDA,(DATE(INPD1),INPD1 =
     1   1,5),TOTWD,K,(EXNEW(INPD2),EXTNE(INPD2),INPD2 = 1,K),TP,KTP,GRN
     2   CO,CANCO
         IF (LP200 .EQ. 2) READ (14) JJJ,ISTOR,NRAIN,TPRES,(RAIN(INPD3),
     1   RAINT(INPD3),INPD3 = 1,NRAIN)
         IF (LP200 .EQ. 3) READ (11) JJJ,ISTOR,TOTWD,SUM1,SUM2,TEMP1,TEM
     1   P2,TWA,STIME,CANCO,GRNCO
         IF (LP200 .EQ. 4) READ (21) JJJ,ISTOR,ITIME,EXT22,EXTKY,TLRIO
         IF (EOF(NTAPE) .NE. 0.0) GO TO 180
         NTIME = ISDAY(JJJ,ISTOR)
         ISTOR = NUMST(NTIME)
         IF (LP200 .EQ. 1) WRITE (94) JJJ,ISTOR,NUMDA,(DATE(INPD4),INPD4
```

```
     1    = 1,5),TOTVO,K,(EXNEW(IMPD5),EXTNE(IMPD5),IMPD5 = 1,K),TP,KTP,
     2   GRNCO,CANCO
         IF (LP200 .EQ. 2) WRITE (94) JJJ,ISTOR,NRAIN,TPRES,(RAIN(IMPD6)
     1   ,RAINT(IMPD6),IMPD6 = 1,NRAIN)
         IF (LP200 .EQ. 3) WRITE (94) JJJ,ISTOR,TOTVO,SUN1,SUN2,TEMP1,TE
     1   MP2,TWA,STIME,CANCO,GRNCO
         IF (LP200 .EQ. 4) WRITE (94) JJJ,ISTOR,EXT22,EXTKK,TLRIO
         GO TO 170
C
C     REWIND FILES.
C
  180    REWIND 94
         IF (LP200 .EQ. 1) REWIND 8
         IF (LP200 .EQ. 2) REWIND 14
         IF (LP200 .EQ. 3) REWIND 11
         IF (LP200 .EQ. 4) REWIND 21
C
C     INPUT DATA FROM DUMMY FILE BACK INTO ORIGINAL FILES.
C
  190    IF (LP200 .EQ. 1) READ (94) JJJ,ISTOR,NUMDA,(DATE(IMPD7),IMPD7
     1   = 1,5),TOTVO,K,(EXNEW(IMPD8),EXTNE(IMPD8),IMPD8 = 1,K),TP,KTP,G
     2   RNCO,CANCO
         IF (LP200 .EQ. 2) READ (94) JJJ,ISTOR,NRAIN,TPRES,(RAIN(IMPD9),
     1   RAINT(IMPD9),IMPD9 = 1,NRAIN)
         IF (LP200 .EQ. 3) READ (94) JJJ,ISTOR,TOTVO,SUN1,SUN2,TEMP1,TEM
     1   P2,TWA,STIME,CANCO,GRNCO
         IF (LP200 .EQ. 4) READ (94) JJJ,ISTOR,EXT22,EXTKK,TLRIO
         IF (EOF(94) .NE. 0.0) GO TO 200
         IF (LP200 .EQ. 1) WRITE (8) JJJ,ISTOR,NUMDA,(DATE(IMP10),IMP10
     1   = 1,5),TOTVO,K,(EXNEW(IMP11),EXTNE(IMP11),IMP11 = 1,K),TP,KTP,G
     2   RNCO,CANCO
         IF (LP200 .EQ. 2) WRITE (14) JJJ,ISTOR,NRAIN,TPRES,(RAIN(IMP12)
     1   ,RAINT(IMP12),IMP12 = 1,NRAIN)
         IF (LP200 .EQ. 3) WRITE (11) JJJ,ISTOR,TOTVO,SUN1,SUN2,TEMP1,TE
     1   MP2,TWA,STIME,CANCO,GRNCO
         IF (LP200 .EQ. 4) WRITE (21) JJJ,ISTOR,EXT22,EXTKK,TLRIO
         GO TO 190
  200 CONTINUE
      IF (NOK .EQ. NOPL) GO TO 250
C
C     OUTPUT ZERO VALUES FOR STORMS WHICH WERE NOT ON A GIVEN PLANE.
C
      DO 240 LP240 = 1,MAXDA
C
C     WHEN THERE WAS NOT A STORM ON A SIMULATION DAY, THERE IS NOTHING
C     NEW TO OUTPUT.
C
         IF (NUMST(LP240) .LE. 0) GO TO 240
         DO 230 LP230 = 1,NOPL
C
C     IF THE PLANE HAD ALL THE STORMS, THERE IS NOTHING NEW TO OUTPUT.
C
            IF (NSTPL(LP230) .GE. NSTMS) GO TO 230
C
C     CHECK TO SEE IF THE STORM OCCURED ON THE PLANE. IF SO, THERE IS
C     NOTHING NEW TO OUTPUT.
C
            NEND = NSTPL(LP230)
            IF (NEND .LE. 0) GO TO 220
            DO 210 LP210 = 1,NEND
               IF (LP240 .EQ. ISDAY(LP230,LP210)) GO TO 230
  210       CONTINUE
C
C     WHEN THE STORM DID NOT OCCUR ON THE PLANE, OUTPUT THE APPROPIATE
C     RECORD ON EACH OF THE FILES: EX1XXY,RAOXXY,RUNXYY, AND TUMXYY.
C
  220       JJJ = LP230
            ISTOR = NUMST(LP240)
            EXT22 = 0.0
            EXTKK = 180.0
            TLRIO = 0.0
```

D-67C

```
      WRITE (21) JJJ,ISTOR,EXT22,EXTKK,TLRIO
      NRAIN = 2
      TPRES = TEMP(LP240)
      RAIN(1) = 0.0
      RAINT(1) = 0.0
      RAIN(2) = 0.0
      RAINT(2) = 180.0
      WRITE (14) JJJ,ISTOR,NRAIN,TPRES,(RAIN(IMP13),RAINT(IMP13),I
     1 MP13 = 1,NRAIN)
      NUMDA = ISTAR + LP240 - 1
      IF (NUMDA .GT. NDSYR) NUMDA = NUMDA - NDSYR
      DATE(1) = 4HDUMM
      DATE(2) = 4HY ZE
      DATE(3) = 4HRO U
      DATE(4) = 4HALUE
      DATE(5) = 4HS
      TOTVO = 0.0
      K = 3
      EXNEW(1) = 0.0
      EXTNE(1) = 0.0
      EXNEW(2) = 0.0
      EXTNE(2) = 180.0
      EXNEW(3) = 0.0
      EXTNE(3) = 1.0E+38
      TP = 0.0
      KTP = 0
      WRITE (8) JJJ,ISTOR,NUMDA,(DATE(IMP14),IMP14 = 1,5),TOTVO,K,
     1 (EXNEW(IMP15),EXTNE(IMP15),IMP15 = 1,K),TP,KTP,GRNCO,CANCO
      TOTVO = 0.0
      SUN1 = SOLAR(LP240)
      SUN2 = SOLAR(LP240)
      TEMP1 = TEMP(LP240)
      TEMP2 = TEMP(LP240)
      TWA = 0.96875 * TEMP(LP240) - 20.3125/9.0
      STIME = 12.0
      WRITE (11) JJJ,ISTOR,TOTVO,SUN1,SUN2,TEMP1,TEMP2,TWA,STIME,C
     1 ANCO,GRNCO
  230 CONTINUE
  240 CONTINUE
  250 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  260 FORMAT (/20X,40HERROR IN STORM NUMBERS ON SIMULATION DAY,1X,I3,1X,
     11H.,/)
      END
```

PROGRAM SORTFIL

```
SORT.
FILE,INPUT=TAPE1,OUTPUT=TAPE2.
FIELD,STORM(.61,.60,INTEGER),STATION(.1,.60,INTEGER)
KEY,STORM(A),STATION(A)
END
```

PROGRAM EXMIN

```
      PROGRAM EXMIN
     1(INPUT,OUTPUT,TAPE1=513,TAPE2=513,TAPE3=513,TAPE4=513,TAPE5=513,TA
     2PE6=513,TAPE7=65,TAPE8=65,TAPE9=65,TAPE10=513,TAPE11=513,TAPE12=OU
     3TPUT,TAPE13=513,TAPE14=513)
C
C     THIS PROGRAM ELIMINATES STORM EVENTS WHOSE RUNOFF DID NOT EXCEED
C     A THRESHOLD LEVEL.
C
C     ################################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ################################################################
C
C     INPUT FILES
C        READ (1)       = EXCXXX
C        READ (3)       = RAIXXX
C        READ (5)       = RUNXXX
C        READ (7,FM)    = UMIXXX
C        READ (9,FM)    = MLIXXX
C        READ (10)      = NGEXXX
C        READ (11)      = E11XXX
C        READ (13)      = VOLXXX
C
C     OUTPUT FILES
C        WRITE (2)      = NECXXX
C        WRITE (4)      = NRAXXX
C        WRITE (6)      = NRUXXX
C        WRITE (8,FM)   = NUMXXX
C        WRITE (11)     = E11XXX
C        WRITE (12,FM)  = LINE PRINTER
C        WRITE (14)     = NVOXXX
C
C     ################################################################
      DIMENSION              AREA(50)    , DATE(5)     , E(200)      ,
     1        ET(200)      , ISED(366)   , ISTAT(3)    , ISTOR(3)    ,
     2        R(200)       , RT(200)
C
C      INITIALIZE SAVED STORM INDICATOR.
C
      DO 11 LP11 = 1,366
         ISED(LP11) = 0
   11 CONTINUE
C
C     SET THE MINIMUN LEVEL FOR RUNOFF.
C
      THRES = 1.27
C
C     INPUTS FROM MLIXXX.  CALCULATE NUMBER OF PLANES.
C
      READ (9,101) NPL,NWS
      NOPL = 2 * NWS + NPL
C
C     INPUTS FROM NGEXXX.  CALCULATE AREA OF PLANES AND TOTAL AREA.
C
      AREAT = 0.0
      DO 21 LP21 = 1,NOPL
         READ (10) SLEN,WIDTH
         AREA(LP21) = SLEN * WIDTH
         AREAT = AREAT + AREA(LP21)
   21 CONTINUE
```

```
C
C     INPUT FROM OLD UMIXXX, AND OUTPUT TO NEW UMIXXX.
C
      READ (7,111) INOUT
      WRITE (8,111) INOUT
C
C     CHECK EVERY STORM FOR AMOUNT OF RUNOFF.
C
   31 REWIND 11
      INDEX = 0
      SUMET = 0.0
C
C     INPUT FROM OLD EXCXXX, AND OUTPUT TO SCRATCH FILE, AND CALCULATE
C     AMOUNT OF RUNOFF.
C
      DO 51 LP51 = 1,NOPL
         READ (1) ISTAT(1),ISTOR(1),NUMDA,(DATE(IMPD1),IMPD1 = 1,5),TOT1
     1   ,NEX,(E(IMPD2),ET(IMPD2),IMPD2 = 1,NEX),TP,KTP,GRNCO,CANCO
         IF (EOF(1) .NE. 0.0) GO TO 71
         WRITE (11) ISTAT(1),ISTOR(1),NUMDA,(DATE(IMPD3),IMPD3 = 1,5),TO
     1   T1,NEX,(E(IMPD4),ET(IMPD4),IMPD4 = 1,NEX),TP,KTP,GRNCO,CANCO
         EXTOT = 0.0
         DO 41 LP41 = 2,NEX
            EXTOT = EXTOT + E(LP41) * (ET(LP41) - ET(LP41 - 1))
   41    CONTINUE
         WRITE (12,121)
         WRITE (12,131) LP51,ISTAT(1),ISTOR(1),TOT1,EXTOT
         SUMET = SUMET + AREA(LP51) * EXTOT
   51 CONTINUE
C
C     RESET INDEX IF THE WEIGHTED AVERAGE IS ABOVE THE THRESHOLD LEVEL.
C
      REWIND 11
      CHECK = SUMET/AREAT
      IF (CHECK .GE. THRES) INDEX = 1
C
C     INPUT STORM AND, PLANE PARAMETERS FROM OTHER FILES, AND IF THE
C     AMOUNT OF RUNOFF WAS ENOUGH, OUTPUT TO NEW FILES.
C
      DO 61 LP61 = 1,NOPL
C
C     INPUT FROM RAIXXX.
C
         READ (3) ISTAT(2),ISTOR(2),NRAIN,T,(R(IMPD5),RT(IMPD5),IMPD5 =
     1   1,NRAIN)
C
C     INPUT FROM RUNXXX.
C
         READ (5) ISTAT(3),ISTOR(3),TOT2,EL1,EL2,TA1,TA2,TW,STIME,CANCV,
     1   GRNCV
C
C     INPUT FROM UMIXXX.
C
         READ (7,141) BT,FT
C
C     INPUT FROM SCRATCH FILE.
C
         READ (11) ISTAT(1),ISTOR(1),NUMDA,(DATE(IMPD6),IMPD6 = 1,5),TOT
     1   1,NEX,(E(IMPD7),ET(IMPD7),IMPD7 = 1,NEX),TP,KTP,GRNCO,CANCO
C
C     OUTPUT DATA FOR CHECKING.
C
         WRITE (12,151)
         WRITE (12,161) LP61,ISTAT(1),ISTOR(1),TOT1,ISTAT(3),ISTOR(3),TO
     1   T2,ISTAT(2),ISTOR(2),T
C
C     IF THE RUNOFF IS TOO SMALL, DO NOT OUTPUT THE STORM.
C
         IF (INDEX .EQ. 0) GO TO 61
C
C     OUTPUT TO NEW EXCXXX.
C
```

D-68b

```
      WRITE (2) ISTAT(1),ISTOR(1),NUMDA,(DATE(IMPD8),IMPD8 = 1,5),TOT
     1  1,NEX,(E(IMPD9),ET(IMPD9),IMPD9 = 1,NEX),TP,KTP,GRNCO,CANCO
C
C     UPDATE SAVED STORM INDICATOR ARRAY.
C
      ISED(NUMDA) = 1
C
C     OUTPUT TO NEW RAIXXX.
C
      WRITE (4) ISTAT(2),ISTOR(2),NRAIN,T,(R(IMP10),RT(IMP10),IMP10 =
     1  1,NRAIN)
C
C     OUTPUT TO NEW RUNXXX.
C
      WRITE (6) ISTAT(3),ISTOR(3),TOT2,EL1,EL2,TA1,TA2,TW,STIME,CANCV
     1  ,GRNCV
C
C     OUTPUT TO NEW UHIXXX.
C
      WRITE (8,141) BT,FT
   61 CONTINUE
C
C     OUTPUT DATA FOR CHECKING.
C
      WRITE (12,171) (ISTOR(IMP11),IMP11 = 1,3),INDEX,CHECK
      GO TO 31
C
C     OUTPUT TO NEW UHIXXX.
C
   71 WRITE (8,181)
C
C     REARRANGE VOLXXX FILE.
C
   81 READ (13) JDATE,QOUT,FRA
      IF (EOF(13) .NE. 0.0) GO TO 91
      INOUT = ISED(JDATE)
      WRITE (14) INOUT,QOUT,FRA
      GO TO 81
C
C     TERMINATE THE PROGRAM NORMALLY.
C
   91 CONTINUE
      STOP
C
C     VARIOUS FORMATS.
C
  101 FORMAT (2I10)
  111 FORMAT (I2)
  121 FORMAT (/20X,10HLOOP INDEX,1X,9HE STATION,1X,9HEXC STORM,1X,9HEX R
     1UNOFF,1X,9HINTEG EXC)
  131 FORMAT (20X,3(1X,I9),2(1X,F9.4))
  141 FORMAT (2(1X,F19.10))
  151 FORMAT (/20X,10HLOOP INDEX,1X,9HE STATION,1X,9HEXC STORM,1X,9HEX R
     1UNOFF,2X,8HRUN STAT,1X,9HRUN STORM,1X,9HRU RUNOFF,2X,8HRAI STAT,1X
     2,9HRAI STORM,1X,9HTEM DEG C)
  161 FORMAT (21X,I9,3(2(1X,I9),1X,F9.4))
  171 FORMAT (/20X,6HISTOR=,3(1X,I3),2X,6HINDEX=,I2,2X,6HCHECK=,E11.4//)
  181 FORMAT (1X,2HNO)
      END
```

PROGRAM FMULTIN

```
      PROGRAM FMULTIN
     1(INPUT,OUTPUT,TAPE65=65,TAPE66=513)
C
C     THIS PROGRAM COMBINES THE INFORMATION ON THE TWO FILES.  THE
C     INFORMATION ON FILE TUMXXX SHOULD HAVE BEEN SORTED.
C
C     ##############################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ##############################################################
C
C     INPUT FILES
C        READ (65,FM)  = UMIXXX
C        READ (66)     = TUMXXX
C
C     OUTPUT FILES
C        WRITE (65,FM) = UMIXXX
C
C     ##############################################################
      READ (65,31) INOUT
      REWIND 65
      WRITE (65,31) INOUT
   11 READ (66) IDUM1,IDUM2,EXTNE,EXTN2,TLRIO
      IF (EOF(66) .NE. 0.0) GO TO 21
      FT = EXTN2 + 3.5 * TLRIO
      WRITE (65,41) EXTNE,FT
      GO TO 11
   21 WRITE (65,51)
C
C     TERMINATE THE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
   31 FORMAT (I2)
   41 FORMAT (2(1X,F19.10))
   51 FORMAT (1X,2HNO)
      END
```

PROGRAM MULT

```
      BLOCK DATA
C
C     DECLARATION OF COMMON BLOCKS IN THE PROGRAM MULTW.
C
      COMMON /ARAYS/        RA(470)
      COMMON /BLOCK/        RB(21)      , IB(17)
      END
      PROGRAM MULT
     1(INPUT,OUTPUT,TAPE1=65,TAPE2=513,TAPE3=65,TAPE5=INPUT,TAPE6=OUTPUT
     2,TAPE7=65,TAPE8=65,TAPE15=65,TAPE16=513,TAPE17=65,TAPE18=513,TAPE1
     39=513,TAPE75=65,TAPE91=513)
C
C     MODIFIED FOR THE HP1000 BY RICHARD MISKIMINS,29 SEPTEMBER 1980.
C
```

```
C     ##############################################################
C     THIS PROGRAM ASKS THE USER FOR THE STORM EVENT THAT WILL BE USED
C     TO RUN THE MODEL.  IT CAN BE ACCESSED IN FOUR WAYS:
C       1.  CALENDAR DATE.
C       2.  EVENT NUMBER.
C       3.  STORM VOLUME.4
C       4.  ROUTE EVERY STORM.
C     ALSO, THE USER IS ASKED TO SUPPLY THE TIME INCREMENT AND FINAL
C     TIME FOR THE HYDROGRAPH IN MINUTES.
C     ##############################################################
C
C
C     ##############################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ##############################################################
C
C     INPUT FILES
C        READ (1,FM)   = GEOXXX
C        READ (2)      = RAIXXX
C        READ (3,FM)   = CONXXX
C        READ (5,FM)   = UMIXXX
C        READ (16)     = EXCXXX
C
C     OUTPUT FILES
C        WRITE (6,FM)  = LINE PRINTER
C        WRITE (7,FM)  = TA7XXX
C        WRITE (8,FM)  = TA8XXX
C        WRITE (15,FM) = T15XXX
C        WRITE (17,FM) = OXCXXX
C        WRITE (18)    = OXHXXX
C        WRITE (19)    = SDMXXX
C        WRITE (75,FM) = MCIXXX
C        WRITE (91)    = AMUXXX
C
C     ##############################################################
      COMMON /ARAYS/        CANCV(2)     , DATEI(5)     , DMBI(10)     ,
     1        GRNCV(2)     , OUTTM(200)  , PLNGH(3)     , PORDS(2)     ,
     2        PSI(10)      , SLOPE(3)    , TYIEL(3)     , Y(200)       ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS         , ADW          , ALP          ,
     1        B1RS         , BET         , CHDOF        , CRS          ,
     2        DCOEF        , DOF         , DPOW         , DTIM         ,
     3        FTIM         , IEF16       , IEVNT        , IPLAN        ,
     4        ISTAT        , ISTOR       , ISTRM        , KPLAN        ,
     5        NEX          , NOPL        , NPL          , NQ           ,
     6        NRAIN        , NSED        , NTOT1        , NUM          ,
     7        NUMP         , NWS         , QT           , RSTNC        ,
     8        TAOCK        , TAREA       , TMPF         , TRVOL        ,
     9        VISCO        , VOLUM       , XN
      COMMON /EMBLK/        ADJ(50)      , DAYI(366,5)  , EXCES(200)   ,
     1        EXCST(200)   , IPRNT(50)   , ISEG(50)     , ITYPE(50)    ,
     2        NUEVT(366)   , QL(200,2)   , QLT(200)     , QLTIM(200)   ,
     3        QOUT(200)    , RAIND(200)  , RAINT(200)   , VOLU(366)
      DIMENSION             DAUSR(5)
      DATA    YES  /3HYES/
C
C     INPUT NUMBER OF PLANES (NPL) AND NUMBER OF SMALL WATERSHEDS
C     (NWS).
C
      READ (3,311) NPL,NWS
C
C     INPUT TYPE ARRAY TO IDENITFY THE TYPE OF UNITS.
C
      NUMP = NPL + NWS
      DO 11 LP11 = 1,NUMP
         READ (3,311) ISEG(LP11),ITYPE(LP11),IPRNT(LP11)
   11 CONTINUE
C
C     INITIALIZE PLANE COUNT VARIABLES.
C
      NTOT1 = 0
      NTOT = 0
```

D-71

```
      DO 21 LP21 = 1,NUMP
         NTOT = NTOT + ITYPE(LP21)
   21 CONTINUE
C
C     ##############################################################
C     TELL USER WHAT THIS PROGRAM IS AND HOW TO START.
C     ##############################################################
C
      WRITE (6,321)
      HELP = 0.0
C
C     USER INSTRUCTIONS.
C
   31 WRITE (6,331)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,351) ICHCE
      IF (ICHCE .EQ. 1) GO TO 41
      IF (ICHCE .EQ. 2) GO TO 91
      IF (ICHCE .EQ. 3) GO TO 141
      IF (ICHCE .EQ. 4) GO TO 251
C
C     USER IS GIVEN FOUR CHANCES TO MAKE A CORRECT RESPONSE.
C
      IF (HELP .EQ. 3.0) GO TO 301
      HELP = HELP + 1.0
C
C     NOTIFY USER OF ERROR.
C
      WRITE (6,361)
      GO TO 31
C
C     ##############################################################
C     SEARCH DATA FILE BY CALENDAR DATE.
C     ##############################################################
C
   41 HELP = 0.0
C
C     USER INSTRUCTIONS.
C
   51 WRITE (6,371)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,381) (DAUSR(IMPD1),IMPD1 = 1,5)
C
C     SEARCH FILE EXCXXX FOR INDICATED EVENT.
C
   61 KPLAN = 1
      CALL INEXC
      IF (IEF16 .EQ. 1) GO TO 81
      CALL INRAI
      DO 71 LP71 = 1,5
         IF (DAUSR(LP71) .NE. DATEI(LP71)) GO TO 61
   71 CONTINUE
C
C     NOTIFY USER OF STORM PARAMETERS.
C
      WRITE (6,391)
      WRITE (6,401) (DATEI(IMPD2),IMPD2 = 1,5),ISTOR,VOLUM
      JEVTS = 1
      WRITE (15,411) JEVTS
      GO TO 281
C
C     USER IS GIVEN FOUR CHANCES TO MAKE A CORRECT RESPONSE.
C
   81 REWIND 16
      REWIND 2
      IF (HELP .EQ. 3.0) GO TO 301
      HELP = HELP + 1.0
```

D-72

```
C
C     NOTIFY USER OF ERROR.
C
      WRITE (6,421)
      GO TO 51
C
C     ##########################################################
C     SEARCH DATA FILE BY EVENT NUMBER.
C     ##########################################################
C
   91 HELP = 0.0
C
C     USER INSTRUCTIONS.
C
  101 WRITE (6,431)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,441) NEVNT
C
C     SEARCH FILE EXCXXX FOR INDICATED EVENT.
C
  111 KPLAN = 1
      CALL INEXC
      IF (IEF16 .EQ. 1) GO TO 131
      CALL INRAI
      IF (ISTOR .EQ. NEVNT) GO TO 121
      GO TO 111
C
C     NOTIFY USER OF STORM PARAMETERS.
C
  121 WRITE (6,391)
      WRITE (6,401) (DATEI(IMPD3),IMPD3 = 1,5),ISTOR,VOLUM
      JEVTS = 1
      WRITE (15,411) JEVTS
      GO TO 281
C
C     USER IS GIVEN FOUR CHANCES TO MAKE A CORRECT RESPONSE.
C
  131 REWIND 16
      REWIND 2
      IF (HELP .EQ. 3.0) GO TO 301
      HELP = HELP + 1.0
C
C     NOTIFY USER OF ERROR.
C
      WRITE (6,421)
      GO TO 101
C
C     ##########################################################
C     SEARCH DATA FILE BY VOLUME OF STORM.
C     ##########################################################
C
  141 HELP = 0.0
C
C     USER INSTRUCTIONS.
C
  151 WRITE (6,451)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,461) VOL
      JEVTS = 0
C
C     INPUT INDICATED EVENTS FROM FILE EXCXXX.
C
  161 DO 171 LP171 = 1,NTOT
        KPLAN = 1
        CALL INEXC
        IF (IEF16 .EQ. 1) GO TO 191
        CALL INRAI
  171 CONTINUE
      IF (VOLUM .LT. VOL) GO TO 161
```

```
C
C     UPDATE ARRAY OF INDICATED EVENTS.
C
      JEVTS = JEVTS + 1
      DO 181 LP181 = 1,5
         DAYI(JEVTS,LP181) = DATEI(LP181)
  181 CONTINUE
      NUEVT(JEVTS) = ISTOR
      VOLU(JEVTS) = VOLUM
      GO TO 161
  191 REWIND 16
      REWIND 2
      IF (JEVTS .EQ. 0) GO TO 241
C
C     LIST INDICATED EVENTS FOR USER.
C
      WRITE (6,471) VOL,JEVTS
      WRITE (6,481) ((DAYI(IMPD5,IMPD4),IMPD4 = 1,5),NUEVT(IMPD5),VOLU(I
     1MPD5),IMPD5 = 1,JEVTS)
C
C     USER INSTRUCTIONS.
C
      WRITE (6,491)
C
C     INPUT USER RESPONSE.
C
      READ (5,501) RMORE
      IF (RMORE .NE. YES) GO TO 231
C
C     RUN EACH EVENT.
C
      DO 221 LP221 = 1,JEVTS
         IF (LP221 .EQ. 1) GO TO 201
         IF (NUEVT(LP221) .LE. NUEVT(LP221 - 1)) REWIND 16
         IF (NUEVT(LP221) .LE. NUEVT(LP221 - 1)) REWIND 2
C
C     SEARCH FILE FOR EACH EVENT.
C
  201    KPLAN = 1
         CALL INEXC
         CALL INRAI
         IF (IEVNT .EQ. NUEVT(LP221)) GO TO 211
         GO TO 201
C
C     NOTIFY USER OF STORM PARAMETERS.
C
  211    WRITE (6,391)
         WRITE (6,401) (DATEI(IMPD6),IMPD6 = 1,5),ISTOR,VOLUM
C
C     RUN MLTWT MODEL.
C
         REWIND 1
         WRITE (91) LP221,IEVNT
         CALL MLTWT
C
C     REINITIALIZE PLANE COUNT.
C
         NTOT1 = 0
  221 CONTINUE
      WRITE (15,411) JEVTS
      GO TO 291
C
C     USER INSTRUCTIONS.
C
  231 WRITE (6,511)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,501) RMORE
      IF (RMORE .NE. YES) GO TO 291
C
C     USER INSTRUCTIONS.
C
```

D-74

```
      WRITE (6,521)
C
C     INPUT USER RESPONSE.
C
      READ (5,441) NEVNT
      GO TO 111
C
C     USER INSTRUCTIONS.
C
  241 WRITE (6,531) VOL
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,501) RMORE
      IF (RMORE .EQ. YES) GO TO 151
      GO TO 291
C
C     ##############################################################
C     ROUTE EVERY EVENT.
C     ##############################################################
C
  251 HELP = 0.0
      WRITE (6,541)
C
C     INPUT INDICATED EVENTS FROM FILE EXCXXX.
C
      JEVTS = 0
  261 KPLAN = 1
      CALL INEXC
      IF (IEF16 .EQ. 1) GO TO 271
      CALL INRAI
C
C     INCREMENT EVENT COUNT.
C
      JEVTS = JEVTS + 1
C
C     NOTIFY USER OF PARAMETERS.
C
      WRITE (6,391)
      WRITE (6,401) (DATEI(IMPD7),IMPD7 = 1,5),ISTOR,VOLUM
      REWIND 1
      WRITE (91) JEVTS,IEVNT
      CALL MLTWT
C
C     REINITIALIZE PLANE COUNT.
C
      NTOT1 = 0
      GO TO 261
  271 REWIND 16
      REWIND 2
      WRITE (6,551) JEVTS
      WRITE (15,411) JEVTS
      GO TO 291
C
C     ##############################################################
C     ASK USER IF THE STORM IS TO BE RUN.
C     ##############################################################
C
  281 HELP = 0.0
C
C     USER INSTRUCTIONS.
C
      WRITE (6,561)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,501) REVNT
      IF (REVNT .NE. YES) GO TO 291
C
C     IF YES, ROUTE THE STORM.
C
      REWIND 1
      WRITE (91) JEVTS,IEVNT
      CALL MLTWT
```

D-75

```
C
C     REINITIALIZE PLANE COUNT.
C
      NTOT1 = 0
C
C     ##############################################################
C     CHECK TO SEE IF USER IS FINISHED WITH PROGRAM.
C     ##############################################################
C
  291 JEVTS = 0
      REWIND 15
      REWIND 91
      REWIND 16
      REWIND 2
C
C     USER INSTRUCTIONS.
C
      WRITE (6,571)
      WRITE (6,341)
C
C     INPUT USER RESPONSE.
C
      READ (5,501) RMORE
      IF (RMORE .EQ. YES) GO TO 31
C
C     ##############################################################
C     TERMINATION OF PROGRAM.
C     ##############################################################
C
      WRITE (6,581)
      STOP
C
C     PROGRAM IS TERMINATED AFTER USER IS UNSUCCESSFUL WITH ANY
C     RESPONSE FOR THE FOURTH TIME.
C
  301 WRITE (6,591)
      CALL EXIT
C
C     ##############################################################
C     VARIOUS FORMATS.
C     ##############################################################
C
  311 FORMAT (3I10)
  321 FORMAT (/20X,55HTHIS IS THE USER PROGRAM FOR THE MULTI-WATERSHED M
     1ODEL.,//20X,58HENTER YOUR RESPONSES ONLY AFTER THE READY SIGNAL IS
     2 GIVEN.,/)
  331 FORMAT (/20X,34HDO YOU WISH TO ACCESS THE MODEL BY,/26X,17H1.  CAL
     1ENDAR DATE,/26X,33H2.  THE EVENT NUMBER OF THE STORM,/26X,24H3.  V
     2OLUME OF THE STORM ,/26X,21H4.  ROUTE EVERY EVENT,//20X,49HENTER T
     3HE NUMBER;I.E.,1,2,3,OR 4; OF YOUR CHOICE.,//)
  341 FORMAT (20X,21HREADY,ENTER RESPONSE.,/)
  351 FORMAT (I2)
  361 FORMAT (/20X,53HSORRY,THE SELECTION RECEIVED WAS NOT 1.,2.,3., OR
     14..,/,20X,45HTRY AGAIN AFTER YOU RECEIVE THE READY SIGNAL.,/)
  371 FORMAT (/20X,71HYOU HAVE CHOSEN TO ACCESS THE DATA BY THE CALENDAR
     1 DATE.  ENTER A BLANK,/,20X,71H, THE TWO DIGIT CODE FOR THE MONTH,
     2AND THE LAST TWO DIGITS OF THE YEAR.,/,20X,48HE.G.,  9 580, IS THE
     3 ENTRY FOR SEPTEMBER 5,1980.,)
  381 FORMAT (5A4)
  391 FORMAT (/20X,12HCALENDAR DAY,9X,12HEVENT NUMBER,4X,16HSTORM VOLUME
     1(CM))
  401 FORMAT (20X,5A4,1X,I12,8X,F12.5/)
  411 FORMAT (1X,I7)
  421 FORMAT (/20X,46HTHE INDICATED EVENT WAS NOT FOUND.  TRY AGAIN.,/)
  431 FORMAT (/20X,42HYOU HAVE CHOSEN TO ACCESS THE DATA BY THE ,/,20X,3
     13HEVENT NUMBER.  ENTER THIS NUMBER.,/)
  441 FORMAT (I3)
  451 FORMAT (/20X,51HYOU HAVE CHOSEN TO ACCESS THE DATA BY THE VOLUME O
     1F,/,20X,51HTHE STORM.  ENTER THE MINIMUM VALUE, IN CENTIMETERS,/,2
     20X,49HWHICH IS OF INTEREST.  ALL STORMS WITH THIS VALUE,/,20X,30HO
     3R GREATER WILL BE REFERENCED.,/)
  461 FORMAT (F50.40)
  471 FORMAT (/20X,51HTHE NUMBER OF EVENTS WITH A MINIMUM STORM VOLUME O
     1F,/20X,F12.5,16H CENTIMETERS IS ,I3,11H.  THEY ARE,//20X,12HCALEND
     2AR DAY,8X,12HEVENT NUMBER,3X,12HSTORM VOLUME)
```

```
481 FORMAT (20X,5A4,I12,E15.5)
491 FORMAT (/20X,41HDO YOU WISH TO ROUTE ALL OF THESE EVENTS?,/)
501 FORMAT (A3)
511 FORMAT (/20X,44HARE ANY OF THESE EVENTS OF FURTHER INTEREST?,/)
521 FORMAT (/20X,18HENTER EVENT NUMBER,/)
531 FORMAT (/20X,42HALL EVENTS HAVE STORM VOLUME SMALLER THAN ,F12.5,4
   1H CM.,/20X,36HDO YOU WISH TO TRY A SMALLER VOLUME?,/)
541 FORMAT (/20X,47HYOU HAVE CHOSEN TO ROUTE EVERY EVENT.  YOU WILL,/,
   120X,48HRECEIVE THE EVENT NUMBER, THE CALENDAR DATE, AND,/,20X,47HV
   2OLUME OF THE STORM.  THEN YOU WILL RECEIVE THE,/,20X,8HRESULTS.,//
   3)
551 FORMAT (/20X,33HTHE TOTAL NUMBER OF STORM EVENTS=,I7)
561 FORMAT (20X,49HDO YOU WISH TO SEE THE RUNOFF AND SEDIMENT YIELD,,/
   1,20X,32HAND A HYDROGRAPH FOR THIS EVENT?,/)
571 FORMAT (/20X,33HDO YOU WISH TO EXAM OTHER EVENTS?,/)
581 FORMAT (/20X,25HEND OF PROGRAM.  GOODBYE.,/)
591 FORMAT (/,20X,49HSORRY,I CAN NOT HELP YOU.  SEEK AID FROM A HUMAN.
   1,/)
    END
```

SUBROUTINE MLTWT

```
      SUBROUTINE MLTWT
C
C     THIS PROGRAM WAS WRITTEN FALL 1977 BY BRENT SPRONK.
C
C     THE PROGRAM IS A MODEL TO SIMULATE RAINFALL RUNOFF FROM A SYSTEM
C     OF MULTIPLE WATERSHEDS. THE BASIC PHYSICAL PROCESSES INVOLVED IN
C     RAINFALL (RUNOFF, INTERCEPTION, INFILTRATION, AND WATER ROUTING)
C     ARE MODELED.
C
C     A SIMPLE ANALYTICAL WATER ROUTING AND YIELD MODEL (CALLED AN
C     'ANWAT' UNIT) IS THE BASIC RESPONSE UNIT USED BY THE MODEL. A
C     LARGE WATERSHED IS BROKEN UP INTO A NUMBER OF THESE UNITS AS
C     DICTATED BY THE BASIN GEOMETRY.  THE ANWAT UNIT MODEL CONSISTS
C     OF AN INTERCEPTION UNIT, AN ANALYTICAL CONTINUOUS INFILTRATION
C     UNIT, AND AN ANALYTICAL WATER ROUTING UNIT. AN ANWAT UNIT
C     REPRESENTS A SUBWATERSHED COMPONENT OF THE LARGE WATERSHED
C     AS AN 'OPEN BOOK' OR WOODING PLANE WATERSHED, OR JUST A SINGLE
C     PLANE.  THE HYDROGRAPHS SIMULATED BY EACH OF THESE UNITS MUST BE
C     COMBINED TO FORM THE TOTAL BASIN RESPONSE.  THE COMBINATION IS
C     ACCOMPLISHED BY THE USE OF A NUMERICAL KINEMATIC WAVE CHANNEL
C     ROUTING UNIT.  THE LINKAGE PROCEDURE SPATIALLY LOCATES EACH
C     RESPONSE UNIT AND TIMES THE ENTRY OF THE HYDROGRAPHS FROM EACH
C     OF THE UNITS TO THE CHANNEL ROUTING UNIT.
C
C     THERE ARE FOUR TYPES OF WATERSHED COMPONENTS:
C
C     1. AN ANWAT UNIT REPRESENTING A SUBWATERSHED UNIT (2 PLANES AND
C        A CHANNEL).
C     2. AN ANWAT UNIT REPRESENTING A SINGLE PLANE.
C     3. A CHANNEL UNIT.
C     4. AN UPSTREAM CONNECTION.
C
C     DATA INPUT - THE INPUT DATA IS INPUT FROM FIVE FILES WHICH WERE
C     PREVIOUSILY CREATED AND DEFINED.  GEOXXX CONTAINS ALL THE ANWAT
C     UNIT DATA (PLANES AND SUBWATERSHEDS).  CONXXX CONTAINS ALL THE
C     CHANNEL UNIT DATA. RAIXXX CONTAINS ALL THE RAINFALL DATA. EXCXXX
C     CONTAINS ALL THE EXCESS RUNOFF DATA. UMIXXX CONTAINS ALL THE
C     HYDROGRAPH TIMING DATA.
C
```

Reproduced from best available copy.

```
C     ##############################################################
C     SECTION NUMBER ONE.
C     ##############################################################
C
C     THIS PROGRAM SECTION CONSISTS OF THE MAIN PROGRAM - MLTWT.
C     MLTWT IS A PROGRAM TO LINK A SMALL WATERSHED MODEL AND A CHANNEL
C     ROUTING METHOD TO SIMULATE RUNOFF HYDROGRAPHS FROM A SYSTEM OF
C     MULTIPLE WATERSHEDS.
C
C     ##############################################################
C
      COMMON /ARAYS/        CANCV(2)     , DATEI(5)     , DMBI(10)     ,
     1        GRNCV(2)    , OUTTM(200)   , PLNGH(3)     , POROS(2)     ,
     2        PSI(10)     , SLOPE(3)     , TYIEL(3)     , Y(200)       ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS         , ADW          , ALP          ,
     1        B1RS        , BET          , CHDOF        , CRS          ,
     2        DCOEF       , DOF          , DPOW         , DTIM         ,
     3        FTIM        , IEF16        , IEVNT        , IPLAN        ,
     4        ISTAT       , ISTOR        , ISTRM        , KPLAN        ,
     5        NEX         , NOPL         , NPL          , NQ           ,
     6        NRAIN       , NSED         , NTOT1        , NUM          ,
     7        NUMP        , NWS          , QT           , RSTNC        ,
     8        TAOCK       , TAREA        , TMPF         , TRVOL        ,
     9        VISCO       , VOLUM        , XN
      COMMON /EMBLK/        ADJ(50)      , DAYI(366,5)  , EXCES(200)   ,
     1        EXCST(200)  , IPRNT(50)    , ISEG(50)     , ITYPE(50)    ,
     2        NUEVT(366)  , QL(200,2)    , QLT(200)     , QLTIM(200)   ,
     3        QOUT(200)   , RAIND(200)   , RAINT(200)   , VOLU(366)
      DIMENSION             BEGN(50)     , FINL(50)
C
C     INPUT VALUES FROM THE FILE UMIXXX AND CALCULATE BEGINNING AND
C     FINAL TIMES , AND THE ADJUSTMENT TIMES FOR EACH PLANE, FOR THE
C     HYDROGRAPHS.
C
      FT = 0.0
      BT = 1.0E30
      NOPL = 2 * NWS + NPL
      WRITE (6,150) NOPL
      DO 100 LP100 = 1,NOPL
         READ (5,160) BEGN(LP100),FINL(LP100)
         IF (BEGN(LP100) .LT. BT) BT = BEGN(LP100)
         IF (FINL(LP100) .GT. FT) FT = FINL(LP100)
  100 CONTINUE
      IF (BT .GE. FT) WRITE (6,170) BT,FT
      IF (BT .GE. FT) CALL EXIT
      WRITE (91) BT
      FT = FT - BT
      DO 110 LP110 = 1,NOPL
         ADJ(LP110) = BEGN(LP110) - BT
  110 CONTINUE
C
C     CALCULATE NUMBER OF INCREMENTS IN HYDROGRAPH.
C
      DTIM = FLOAT( IFIX (FT/198.0) ) + 1.0
      FTIM = FLOAT( IFIX (FT/DTIM) + 1) * DTIM
      NUM = IFIX (FTIM/DTIM) + 1
      WRITE (75,180) DTIM,FTIM
C
C     CONVERT TIMES TO SECONDS.
C
      DTIM = DTIM * 60.0
      FTIM = FTIM * 60.0
C
C     IF NO CHANNEL NEEDS TO BE ROUTED THEN USE ONLY THE SMALL
C     WATERSHED MODEL (ANWAT). IN THIS CASE, NUMP = 1.
C
      IF (NUMP .EQ. 1) GO TO 120
      WRITE (8,190) NWS,NUM
      WRITE (7,190) NPL,NUM
  120 DO 140 LP140 = 1,NUMP
         CALL ANWAT
         IF (NUMP .EQ. 1) GO TO 130
C
C     KPLAN = 1 INDICATES THE ONE PLANE CASE.
C     KPLAN = 3 INDICATES THE SUBWATERSHED CASE (2-PLANES & 1-CHANNEL).
C
```

```
      KTAPE = (KPLAN + 13)/2
      WRITE (KTAPE,190) ISEG(LP140),NSED
      WRITE (KTAPE,200)  (YIELD(IMPD1,KPLAN),IMPD1 = 1,NSED)
      WRITE (KTAPE,200) QT
      WRITE (KTAPE,200) (QOUT(IMPD2),IMPD2 = 2,NUM)
      IF (IFRNT(LP140) .LT. 0) GO TO 140
C
C     CONVERT TOTALS FROM CUBIC FEET PER SECOND TO ACRE-FEET UNITS.
C
  130 TAREA = TAREA/43560.0
      TRVOL = TRVOL/43560.0
      CALL OUTPT (LP140)
  140 CONTINUE
      RETURN
  150 FORMAT (20X,60HENTER BEGINNING TIME AND FINAL TIME FOR RUNOFF (IN
     1MINUTES.),/20X,41HENTER ONE LINE FOR EACH PLANE.  THERE ARE,1X,I3,
     21X,7HPLANES.)
  160 FORMAT (2(1X,F19.10))
  170 FORMAT (20X,26HERROR IN DATA, BEGIN TIME=,E20.10,1X,11HFINAL TIME=
     1,E20.10)
  180 FORMAT (2(1X,F9.2))
  190 FORMAT (2I10)
  200 FORMAT (4E20.10)
      END
```

SUBROUTINE ANWAT

```
      SUBROUTINE ANWAT
C
C     ################################################################
C     SECTION NUMBER TWO.
C     ################################################################
C
C     THIS PROGRAM SECTION CALCULATES THE RUNOFF HYDROGRAPH, VOLUME OF
C     INTERCEPTION, AND VOLUME OF INFILTRATION. THESE CALCULATIONS ARE
C     DONE FOR A SUBWATERSHED UNIT WITH THE 2-PLANES AND 1-CHANNEL OR
C     JUST A SINGLE PLANE UNIT.
C
C     ################################################################
C
C     THIS UNIT IS A MODIFIED VERSION OF THE ANWAT PROGRAM WRITTEN BY
C     K.G. EGGERT. THE PROGRAM UNIT IS BASED ON THE WOODING 2-PLANES &
C     1-CHANNEL APPROXIMATION TO A SUBWATERSHED.  THE EXCESS RAINFALL
C     IS CALCULATED AND THEN THE ROUTING IS DONE BY AN ANALYTICAL
C     SOLUTION.
C
C     PARAMETER DEFINITIONS.
C
C        DTIM  = TIME INCREMENT FOR HYDROGRAPH.
C        FTIM  = FINAL TIME OF HYDROGRAPH.
C        QOUT  = ARRAY OF THE RESULTING DISCHARGES.
C        TAREA = TOTAL AREA IN SQUARE FEET.
C        TRVOL = TOTAL VOLUME OF RAINFALL IN CUBIC FEET.
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1        GRNCV(2)    , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2        PSI(10)     , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
```

D-79

```
      COMMON /EMBLK/        ADJ(50)      , DAYI(366,5) , EXCES(200)  ,
     1        EXCST(200)  , IPRNT(50)    , ISEG(50)    , ITYPE(50)   ,
     2        NUEVT(366)  , QL(200,2)    , QLT(200)    , QLTIM(200)  ,
     3        QOUT(200)   , RAIND(200)   , RAINT(200)  , VOLU(366)
      DIMENSION             NGP(2)       , QLRIO(200)
C
C     INITIALIZE VARIABLES.
C
      TRVOL = 0.0
      TAREA = 0.0
      DO 100 LP100 = 1,200
         QLT(LP100) = 0.0
         QLTIM(LP100) = 0.0
  100 CONTINUE
      DO 110 LP110 = 1,10
         YIELD(LP110,1) = 0.0
         YIELD(LP110,2) = 0.0
         YIELD(LP110,3) = 0.0
  110 CONTINUE
C
C     INPUT ALL DATA FOR ANWAT FROM GEOXXX.
C
      CALL INGEO
C
C     THE FOLLOWING LOOP CALCULATES THE EXCESS RAINFALL ON EACH PLANE
C     AND ROUTS THE EXCESS RAINFALL ON EACH PLANE.
C
      DO 180 KPLAN = 1,IPLAN
         IF (NTOT1 .NE. 0) CALL INRAI
C
C     CALCULATE VISCOSITY AND CORRECT HYDRAULIC CONDUCTIVITY FOR
C     TEMPERATURE.
C
         CALL TEMP
C
C     CALCULATE TOTAL INCHES OF RAINFALL.
C
         TRNCH = RAIND(1) * RAINT(1)
         DO 120 LP120 = 2,NRAIN
            TRNCH = RAIND(LP120) * (RAINT(LP120) - RAINT(LP120 - 1)) + T
     1      RNCH
  120    CONTINUE
C
C     CALCULATE AREA OF PLANE (AREA).
C
         AREA = PLNGH(KPLAN) * PLNGH(3)
         TAREA = TAREA + AREA
C
C     CALCULATE RAINFALL VOLUME.
C
         TRVOL = TRVOL + AREA * TRNCH/12.0
         IF (NTOT1 .EQ. 0) GO TO 130
C
C     FIND EXCESS DATA IN INCHES PER MINUTE AND WITH UNITS OF TIME IN
C     MINUTES.
C
         CALL INEXC
  130    NTOT1 = NTOT1 + 1
  140    IF (NTOT1 .GT. NOPL) NTOT1 = NTOT1 - NOPL
         IF (NTOT1 .GT. NOPL) GO TO 140
C
C     CONVERT UNITS OF EXCESS RAINFALL FROM INCHES PER MINUTE TO FEET
C     PER SECOND AND UNITS OF TIME FROM MINUTES TO SECONDS, AFTER
C     ADJUSTING THE TIME ARRAY.
C
         DO 150 LP150 = 1,NEX
            EXCES(LP150) = EXCES(LP150)/720.0
            EXCST(LP150) = EXCST(LP150) + ADJ(NTOT1)
            EXCST(LP150) = EXCST(LP150) * 60.0
  150    CONTINUE
C
C     DEFINE BET. BET IS USED IN THE EQUATION Q=ALP*Y**BET.  BET = 3.0
C     FOR THE CASE OF OVERLAND FLOW.
C
         BET = 3.0
```

```
C
C     DEFINE ALP. ALP IS USED IN THE EQUATION Q=ALP*Y**BET.  FOR
C     OVERLAND FLOW, ALP IS A FUNCTION OF THE GROUND COVER, SLOPE, AND
C     VISCOSITY OF WATER.
C
         RSTNC = 100.0 + (ADW - 100.0) * (GRNCV(KPLAN)/100.0) *  * 2.0
         ALP = 8.0 * SLOPE(KPLAN) * 32.174/(RSTNC * VISCO)
C
C     CALL THE FRWRD ROUTING PROCEDURE.
C
         CALL OXCWR
         CALL FRWRD (EXCES,EXCST,NEX)
         CALL BACK (EXCST,EXCES,QOUT,NEX)
         DO 160 LP160 = 1,200
            QL(LP160,KPLAN) = QOUT(LP160)
  160    CONTINUE
         CALL PLANE
         WRITE (19) ISTRM,ISTAT,NSED,(YIELD(IMPD1,KPLAN),IMPD1 = 1,NSED)
     1   ,(DMBI(IMPD2),IMPD2 = 1,NSED)
         DTRIO = DTIM/60.0
         DO 170 LP170 = 1,NUM
            QLRIO(LP170) = QL(LP170,KPLAN) * (1.0/10.7639)
  170    CONTINUE
         WRITE (18) DTRIO,NUM,(QLRIO(IMPD3),IMPD3 = 1,NUM)
  180 CONTINUE
      IF (IPLAN .EQ. 2) GO TO 210
      KPLAN = 1
      QT = 0.0
      DO 190 LP190 = 2,NUM
         QT = QT + (QOUT(LP190) + QOUT(LP190 - 1))/2.0
  190 CONTINUE
      QT = QT * PLNGH(3) * DTIM/43560.0
      DO 200 LP200 = 1,NSED
         YIELD(LP200,1) = YIELD(LP200,1)/PLNGH(3)
  200 CONTINUE
      RETURN
C
C     TO ROUTE THE CHANNEL CALL QLAT TO SUM THE LATERAL INFLOWS.
C
  210 DO 230 LP230 = 1,2
         NQP(LP230) = 0
         DO 220 LP220 = 1,200
            IF (QL(LP220,LP230) .GT. 0.0) NQP(LP230) = LP220
  220    CONTINUE
  230 CONTINUE
      NQ = MAX0(NQP(1),NQP(2)) + 1
      IF (NQ .GE. 200) WRITE (6,260) NQ
      IF (NQ .GE. 200) NQ = 199
      CALL QLAT
      IF (A1RS .NE. 0.0) GO TO 240
C
C     THIS IS THE CASE WHEN THE TRIANGULAR APPROXIMATION FOR THE
C     CHANNEL SHAPE IS USED.
C
C     DEFINE B1RS.  B1RS IS USED IN THE EQUATION P=A1RS*AREA**B1RS.
C     FOR A CHANNEL WITH A TRIANGULAR CROSS SECTION:  B1RS = 0.5.
C
      B1RS = 0.5
C
C     DEFINE A1RS.  A1RS IS USED IN THE EQUATION P=A1RS*AREA**B1RS.
C     FOR A CHANNEL A1RS IS A FUNCTION OF THE SLOPES OF THE PLANES.
C
      A1RS = ((2.0/((1.0/SLOPE(1)) + (1.0/SLOPE(2)))) *  * 0.5) * ((1.0
     1+ (1.0/SLOPE(1) *  * 2)) *  * 0.5 + (1.0 + (1.0/SLOPE(2) *  * 2))
     2*  * 0.5)
C
C     ROUTE CHANNEL.
C
  240 CALL RESIS
      KPLAN = 3
      CALL FRWRD (QLT,QLTIM,NQ)
      CALL BACK (QLTIM,QLT,QOUT,NQ)
      CALL CHNL
      QT = 0.0
      DO 250 LP250 = 2,NQ
         QT = QT + (QOUT(LP250 - 1) + QOUT(LP250))/2.0
  250 CONTINUE
      QT = QT * DTIM/43560.0
      RETURN
  260 FORMAT (//20X,3HNQ=,I9)
      END
```

D-21

SUBROUTINE BACK (TIMIN, QIN, QBACK, NEXQ)

```
      SUBROUTINE BACK (TIMIN,QIN,QBACK,NEXQ)
C
C     THIS UNIT USES THE SUBDIVIDED SOLUTION DOMAIN AS SUPPLIED BY
C     THE UNIT FRWRD TO CALCULATE THE TIME OF ORIGIN OF CHARACTERIS-
C     TICS CORRESPONDING TO AN ARBITRATILY SELECTED TIME ON THE DOWN-
C     STREAM BOUNDARY.  IN SHORT, BACK CALCULATES CHARACTERISTICS IN
C     THE UPSTREAM DIRECTION. THIS ALLOWS THE DISCHARGE TO BE KNOWN
C     AT CONVENIENT TIME INTERVALS THEREBY FACILITATING THE FORMATION
C     OF THE LATERAL INFLOW TO THE CHANNEL AND ALLOWING GREATER EASE
C     IN INTERFACING THIS WATER ROUTING SIMULATION WITH OTHER WATER-
C     SHED PROCESS MODELS.
C
C     THE UNIT BACK PROCEEDS AS FOLLOWS:
C
C     FIRST: IT DETERMINES THE LOCATION OF THE TIME OF INTEREST ON THE
C     DOWNSTREAM BOUNDARY WITH RESPECT TO THE CHARACTERISTICS SUPPLIED
C     BY THE UNIT FRWRD.
C
C     SECOND: THE UNIT FORMULATES (FTO) AND ITS FIRST TWO DERIVATIVES
C     AS SHOWN IN EQS 3-15 TO 3-17 IN THE ANWAT REPORT TEXT.
C
C     FINALLY: THIS RESULT IS ITERATED UNTIL A SUITABLY ACCURATE ESTI-
C     MATE OF THE TIME OF ORIGIN IS CALCULATED BY USING A SECOND ORDER
C     NEWTONS METHOD.
C
C     PARAMETER DEFINITIONS.
C
C        ALP   = A IN Q=A*Y**B.
C        BET   = B IN Q=A*Y**B.
C        PLNGH = SLOPE LENGTH (FEET).
C        DTIM  = TIME INCREMENT FOR HYDROGRAPH (SECONDS).
C        FTIM  = ENDING TIME OF HYDROGRAPH (SECONDS).
C        OUTTM = ARRAY OF FINAL TIMES FOR THE CHARACTERISTIC LINES
C                FOUND IN THE UNIT FRWRD (SECONDS).
C        KPLAN = INDEX OF THE PLANE IN THE ANWAT UNIT.
C        TIMIN = TIME ARRAY FOR INFLOW (SECONDS).
C        QIN   = INFLOW ARRAY (FEET PER SECOND OR CUBIC FEET PER
C                SECOND).
C        QBACK = OUTFLOW DISCHARGES (CUBIC FEET PER SECOND PER FOOT OR
C                CUBIC FEET PER SECOND).
C        NEXQ  = NUMBER OF INCREMENTS IN INFLOW.
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1       GRNCV(2)     , OUTTM(200)  , PLNGH(3)    , FOROS(2)    ,
     2       PSI(10)      , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3       YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1       B1RS         , BET         , CHDOF       , CRS         ,
     2       DCOEF        , DOF         , DPOW        , DTIM        ,
     3       FTIM         , IEF16       , IEVNT       , IPLAN       ,
     4       ISTAT        , ISTOR       , ISTRM       , KPLAN       ,
     5       NEX          , NOPL        , NPL         , NQ          ,
     6       NRAIN        , NSED        , NTOT1       , NUM         ,
     7       NUMP         , NWS         , QT          , RSTHC       ,
     8       TAOCK        , TAREA       , TMPF        , TRVOL       ,
     9       VISCO        , VOLUM       , XN
      DIMENSION             CUMQ(200)
      DIMENSION             QBACK(200)  , QIN(200)    , TIMIN(200)
C
C     ONE TIME INITIALIZATION OF LOOP PARAMETERS AND TIMES.
C
      EPQ = 1.0E - 5
      IF (KPLAN .EQ. 3) EPQ = EPQ * PLNGH(KPLAN)
      TIME = 0.0
      B1 = BET - 1.0
      B2 = BET - 2.0
      B3 = BET - 3.0
C
C     CALCULATE CUMLATIVE INFLOW ARRAY.
C
      Y(1) = 0.0
      QBACK(1) = 0.0
      TOT = QIN(1) * TIMIN(1)
      CUMQ(1) = TOT
```

Reproduced from best available copy.

```
      DO 100 LP100 = 2,200
         TOT = TOT + QIN(LP100) * (TIMIN(LP100) - TIMIN(LP100 - 1))
         CUMQ(LP100) = TOT
         Y(LP100) = 0.0
         QBACK(LP100) = 0.0
  100 CONTINUE
      I = 1
  110 IF (OUTTM(I) .NE. OUTTM(I + 1)) GO TO 120
      I = I + 1
      GO TO 110
C
C     THIS LOOP ITERATES FINAL TIMES FROM 0.0 TO FTIM. FOR EACH FINAL
C     TIME AN INITIAL TIME (TEST) IS CALCULATED.
C
  120 DO 300 LP300 = 2,200
         TIME = TIME + DTIM
C
C     THIS SECTION IS USED TO CALCULATE THE DISCHARGE FOR ALL TIMES
C     LESS THAN OUTTM(1).  FOR THESE TIMES IT IS NOT NECESSARY TO GO
C     CALCULATE THE UPSTREAM TIME OF THE CHARACTERISTIC SINCE ALL OF
C     THESE CHARACTERISTICS BEGIN AT T = 0.0.

         IF (TIME .GT. FTIM) GO TO 310
         IF (TIME .GT. OUTTM(1)) GO TO 130
         CALL INTGR (0.0,TIME,DEPTH,QIN,TIMIN,NEXQ)
         QBACK(LP300) = ALP * DEPTH **  * BET
         Y(LP300) = DEPTH
         GO TO 300
  130    IK = I
C
C     FIND THE BOUNDS FOR THE CHARACTERISTIC LINE.
C
         DO 140 LP140 = IK,200
            IF (TIME .LE. OUTTM(LP140 + 1)) GO TO 150
            I = I + 1
  140    CONTINUE
  150    L2 = I
C
C     IF THE LATERAL INFLOW INTENSITY IS EQUAL TO ZERO, IT IS
C     NECESSARY TO SKIP UP TO THE NEXT CHARACTERISTIC.
C
         IF (QIN(L2 + 1) .NE. 0.0) GO TO 160
         I = I + 1
         GO TO 150
  160    CALL INDEX (TIME,L,NEXQ,TIMIN)
         M = L - L2 - 1
C
C     THE FIRST GUESS OF THE TIME OF ORIGIN TO BE CALCULATED (TEST) IS
C     THE AVERAGE OF THE TIME OF ORIGIN OF THE LOWER BOUNDING CHARAC-
C     TERISTIC, AND THE SMALLER OF THE TIME ORIGIN OF THE UPPER BOUND-
C     ING CHARACTERISTIC AND 'TIME'.
C
         TUP = TIMIN(I + 1)
         IF (TUP .GT. TIME) TUP = TIME
         TEST = (TIMIN(I) + TUP)/2.0
C
C     THIS IS AN ANALYTICAL SOLUTION USING A THIRD ORDER NEWTON
C     APPROXIMATION TO SOLVE FOR THE CHARACTERISTIC LINE.
C
         DO 280 LP280 = 1,10
            FF =  - PLNGH(KPLAN)/(ALP * BET)
            FTO = FF
            TLAST = TEST
            IF (M .EQ. 0) GO TO 210
            C1 = QIN(L2 + 1) * TIMIN(L2 + 1) - QIN(L2 + 1) * TEST
            FTO = FTO + (1.0/(QIN(L2 + 1) * BET)) * (C1 **  * BET)
            FDTO =  - (C1 **  * B1)
            FD2TO = QIN(L2 + 1) * B1 * (C1 **  * B2)
            IF (M .EQ. 1) GO TO 190
            DO 180 LP180 = 2,M
               JJ = L2 + LP180
               A =  - QIN(JJ) * TIMIN(JJ - 1) + CUMQ(JJ - 1) - CUMQ(L2)
     1         + QIN(L2 + 1) * TIMIN(L2)
               IF (QIN(JJ) .NE. 0.0) GO TO 170
               C1 =  - QIN(L2 + 1) * TEST + A
```

D-83

```
      CDT = TIMIN(JJ) - TIMIN(JJ - 1)
      FTO = FTO + CDT * (C1 *  * B1)
      FDTO = FDTO + B1 * ( - QIN(L2 + 1)) * CDT * (C1 *  * B2)
      FD2TO = FD2TO + B1 * B2 * QIN(L2 + 1) * QIN(L2 + 1) * CDT
     1 * (C1 *  * B3)
      GO TO 180
170   C1 = QIN(JJ) * TIMIN(JJ) - QIN(L2 + 1) * TEST + A
      C2 = QIN(JJ) * TIMIN(JJ - 1) - QIN(L2 + 1) * TEST + A
      FTO = FTO + (1.0/(BET * QIN(JJ))) * ((C1 *  * BET) - (C2
     1 *  * BET))
      FDTO = FDTO + ( - QIN(L2 + 1)/QIN(JJ)) * ((C1 *  * B1) -
     1 (C2 *  * B1))
      FD2TO = FD2TO + (QIN(L2 + 1) * QIN(L2 + 1)/QIN(JJ)) * B1
     1 * ((C1 *  * B2) - (C2 *  * B2))
180   CONTINUE
190   A =  - QIN(L) * TIMIN(L - 1) + CUMQ(L - 1) - CUMQ(L2) + QIN(
     1 L2 + 1) * TIMIN(L2)
      IF (QIN(L) .NE. 0.0) GO TO 200
      C1 = A - QIN(L2 + 1) * TEST
      CDT = TIME - TIMIN(L - 1)
      FTO = FTO + CDT * (C1 *  * B1)
      FDTO = FDTO + CDT * B1 * ( - QIN(L2 + 1)) * (C1 *  * B2)
      FD2TO = FD2TO + CDT * B1 * B2 * QIN(L2 + 1) * QIN(L2 + 1) *
     1 (C1 *  * B3)
      GO TO 220
200   C1 = QIN(L) * TIME - QIN(L2 + 1) * TEST + A
      C2 = QIN(L) * TIMIN(L - 1) - QIN(L2 + 1) * TEST + A
      IF ((C1 .LT. 0.0) .OR. (C2 .LT. 0.0)) GO TO 260
      FTO = FTO + (1.0/(QIN(L) * BET)) * ((C1 *  * BET) - (C2 *  *
     1 BET))
      FDTO = FDTO + ( - QIN(L2 + 1)/(QIN(L))) * ((C1 *  * B1) - (C
     1 2 *  * B1))
      FD2TO = FD2TO + ((QIN(L2 + 1) * QIN(L2 + 1))/QIN(L)) * B1 *
     1 ((C1 *  * B2) - (C2 *  * B2))
      GO TO 220
210   TEST = TIME - ((PLNGH(KPLAN)/(ALF * (QIN(L) *  * B1))) *  *
     1 (1.0/BET))
      GO TO 290
C
C     TEST FOR CONVERGENCE.  IF TEST IS SUCCESSFUL, THE ITERATIONS ARE
C     COMPLETE.  THE PROGRAM THEN PROCEEDS TO THE NEXT TIME INCREMENT.
C     IF NOT, THE PROGRAM USES THE SOLUTION TO A TRUNCATED TAYLOR'S
C     SERIES TO CALCULATE A NEW TRAIL VALUE OF TEST.
C
220   IF (ABS(FTO/FF) .LE. 0.0001) GO TO 290
      B = (2.0 * FDTO/FD2TO) - (2.0 * TEST)
      CBACK = (2.0/FD2TO) * (FTO - FDTO * TEST + 0.5 * TEST * TEST
     1 * FD2TO)
      D = B * B - 4.0 * CBACK
      IF (D .LT. 0.0) GO TO 230
      DTEST = 0.5 * SQRT(D)
      GO TO 240
C
C     THE NEW ESTIMATE OF TEST MUST FALL INSIDE THE REGION OF THE SOLU-
C     TION DOMAIN BOUNDED BY THE CHARACTERISTICS SELECTED ABOVE.  IF
C     IT DOES NOT, THEN AN ESTIMATE MUST BE REPICKED INSIDE THAT RE-
C     GION.  THIS PROCEDURE MAY RESULT IN THE REJECTION OF THE ESTIMATE
C     PROVIDED BY THE NEWTON'S METHOD.  AND THE SUBSTITUTION OF A NEW
C     AVERAGE VALUE AS THE NEW GUESS OF TEST.
C
230   TEST = TEST - FTO/FDTO
      IF ((TEST .LT. TUP) .AND. (TEST .GE. TIMIN(I))) GO TO 280
      GO TO 250
240   DTEST = 0.5 * (SQRT(B * B - 4.0 * CBACK))
      IF (ABS(FTO/FF) .LE. 0.0001) GO TO 290
      TEST = 0.5 * ( - B) - DTEST
      IF ((TEST .LT. TUP) .AND. (TEST .GT. TIMIN(I))) GO TO 280
      TEST = 0.5 * ( - B) + DTEST
      IF ((TEST .LT. TUP) .AND. (TEST .GE. TIMIN(I))) GO TO 280
      TEST = TLAST
      GO TO 230
250   IF (TEST .GE. TUP) GO TO 270
260   TEST = (TLAST + TIMIN(I))/2.0
      GO TO 280
```

```
  270       TEST = (TLAST + TUP)/2.0
  280    CONTINUE
C
C     THE VALUES OF DEPTH (OF CROSS-SECTIONAL AREA FOR CHANNELS) AND
C     DISCHARGE ARE NOW CALCULATED. A TEST IS MADE TO DETERMINE IF THE
C     DISCHARGE IS NEGLIGIBLY SMALL OR IF THE PRESELECTED DURATION OF
C     THE HYDROGRAPH HAS BEEN EXCEEDED. IF SO THE UNIT RETURNS CONTROL
C     TO THE UNIT ANWAT.
C
  290    CALL INTGR (TEST,TIME,DEPTH,QIN,TIMIN,NEXQ)
         QBACK(LP300) = ALP * DEPTH *  * BET
         Y(LP300) = DEPTH
         IF ((TIME .GE. TIMIN(NEXQ - 1)) .AND. (QBACK(LP300) .LE. EPQ))
     1   GO TO 310
  300 CONTINUE
  310 CONTINUE
      RETURN
      END
```

SUBROUTINE CHNL

```
      SUBROUTINE CHNL
C
C     THIS UNIT CALCULATES THE AMOUNT OF SEDIMENT GENERATED IN THE
C     CHANNEL UNIT OF A WATERSHED DUE TO THE INFLOW FROM THE PLANES.
C
C     ##########################################################
C     USER WRITTEN EXTERNALS:  POWER
C     ##########################################################
C
C     THE TOTAL SEDIMENT INFLOW FROM THE PLANES IS CALCULATED (TSDLT).
C     ALSO, THE INFLOW FOR EACH SIZE FRACTION IS DETERMINED (SEDLT).
C     THE TOTAL TRANSPORT CAPACITY FOR EACH SIZE (TSEDQ) IS INITIAL-
C     IZED.
C
      COMMON /ARAYS/        CANCV(2)     , DATEI(5)     , DMBI(10)     ,
     1        GRNCV(2)    , OUTTM(200)   , PLNGH(3)     , POROS(2)     ,
     2        PSI(10)     , SLOPE(3)     , TYIEL(3)     , Y(200)       ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS         , ADW          , ALP          ,
     1        B1RS        , BET          , CHDOF        , CRS          ,
     2        DCOEF       , DOF          , DPOW         , DTIM         ,
     3        FTIM        , IEF16        , IEVNT        , IPLAN        ,
     4        ISTAT       , ISTOR        , ISTRM        , KPLAN        ,
     5        NEX         , NOPL         , NPL          , NQ           ,
     6        NRAIN       , NSED         , NTOT1        , NUM          ,
     7        NUMP        , NWS          , QT           , RSTNC        ,
     8        TAOCK       , TAREA        , TMPF         , TRVOL        ,
     9        VISCO       , VOLUM        , XN
      COMMON /EMBLK/       ADJ(50)       , DAYI(366,5)  , EXCES(200)   ,
     1        EXCST(200)  , IPRNT(50)    , ISEG(50)     , ITYPE(50)    ,
     2        NUEVT(366)  , QL(200,2)    , QLT(200)     , QLTIM(200)   ,
     3        QOUT(200)   , RAIND(200)   , RAINT(200)   , VOLU(366)
      DIMENSION             SEDLT(10)    , SEDQ(10)     , TSEDQ(10)
      TSDLT = 0.0
      DO 100 LP100 = 1,NSED
         SEDLT(LP100) = YIELD(LP100,1) + YIELD(LP100,2)
         TSDLT = TSDLT + SEDLT(LP100)
         TSEDQ(LP100) = 0.0
  100 CONTINUE
      SSEDQ = 0.0
      T = 0.0
C
C     THIS LOOP CALCULATES THE TRANSPORT CAPACITY FOR ALL THE SIZE
C     FRACTIONS FOR EACH CALCULATED DISCHARGE.
C
```

```
      DO 150 LP150 = 2,200
         T = T + DTIM
         IF (T .GT. FTIM) GO TO 160
         IF (QOUT(LP150) .EQ. 0.0) GO TO 150
C
C     THIS SECTION CALCULATES THE HYDRAULIC RADIUS AND THE MEAN VELO-
C     CITY OF THE CHANNEL FLOW.
C
         WEPER = A1RS * Y(LP150) **  * B1RS
         HYRAD = Y(LP150)/WEPER
         VMEAN = QOUT(LP150)/Y(LP150)
C
C     EFFECTIVE SHEAR STRESS.
C
         TAO = 0.2425 * 0.025 * VMEAN **  * 2.0
         SUMPS = 0.0
C
C     THIS LOOP CALCULATES THE BEDLOAD AND SUSPENDED LOAD TRANSPORT
C     FOR EACH SIZE FRACTION.
C
         DO 140 LP140 = 1,NSED
C
C     CRITICAL SHEAR STRESS.
C
            TAOC = 102.96 * TAOCK * DMBI(LP140)
C
C     CHECK TO SEE IF EXCESS SHEAR EXISTS.
C
            IF ((TAO .GT. TAOC) .AND. (QOUT(LP150) .GT. 0.0)) GO TO 110
            SEDQ(LP140) = 0.0
            SUSP = 0.0
            GO TO 130
C
C     BEDLOAD CALCULATION USING THE MEYER-PETER,MUELLER EQUATION.
C
 110        SEDQ(LP140) = (12.85/1.392) * (TAO - TAOC) **  * (1.5)
C
C     SHEAR VELOCITY.
C
            SV = SQRT(62.4 * HYRAD * SLOPE(3)/1.938)
C
C     FALL VELOCITY CALCULATION.
C
            FVB = (SQRT(36.064 * DMBI(LP140) **  * 3.0 + 36.0 * VISCO *
     1      * 2.0) - 6.0 * VISCO)/DMBI(LP140)
            IF (DMBI(LP140) .LE. 0.0002) FVB = 2.9517 * DMBI(LP140) **  *
     1       2.0/VISCO
C
C     CALCULATE THE PARAMETERS FOR EINSTIEN'S SUSPENDED SEDIMENT LOAD
C     APPROXIMATION.
C
            ZR = FVB/(0.4 * SV)
            AR = 2.0 * DMBI(LP140)/HYRAD
            SUSMX = 1.0/AR
            IF ((ZR .GT. 5.5) .OR. (AR .GT. 0.5)) GO TO 120
C
C     EVALUATE J1 AND J2.
C
            CONV = 1.0E - 2
            CALL POWER (ZR,AR,XJ1,XJ2,CONV)
            P = AR **  * (ZR - 1.)/(11.6 * (1. - AR) **  * ZR)
            BMV = 2.5 + VMEAN/SV
            SUSP = P * (BMV * XJ1 + 2.5 * XJ2)
            IF (SUSP .LE. 0.0) SUSP = 0.0
            IF (SUSP .GE. SUSMX) SUSP = SUSMX
            GO TO 130
 120        SUSP = 0.0
C
C     CALCULATE THE TOTAL SEDIMENT TRANSPORT CAPACITY FOR THIS SIZE
C     FRACTION (TSEDQ).  UPDATE TRANSPORTING CAPACITY FOR THIS SIZE
C     FRACTION AT THIS TIME INCREMENT FOR SUSPENDED SEDIMENT.  UPDATE
C     THE TOTAL TRANSPORT RATE FOR THIS TIME INCREMENT.
C
```

D-86

```
130       SEDQ(LP140) = (1.0 + SUSP) * SEDQ(LP140) * WEPER * PSI(LP140
   1      )
          TSEDQ(LP140) = TSEDQ(LP140) + SEDQ(LP140) * DTIM
          SUMPS = SUMPS + SEDQ(LP140)
140     CONTINUE
C
C     CALCULATE THE TOTAL SEDIMENT TRANSPORT CAPACITY FOR ALL SIZES.
C
        SSEDQ = SSEDQ + SUMPS * DTIM
150 CONTINUE
C
C     CALCULATION OF CHANNEL FLOW DETACHMENT.
C
160 DA = CHDOF * (SSEDQ - TSDLT)
    IF (DA .LT. 0.0) DA = 0.0
C
C     REDISTRIBUTE THE AVAILABLE SEDIMENT IN PROPORTION TO THE PARENT
C     MATERIAL, THEN COMPUTE THE YIELD FOR EACH SIZE.
C
    TYIEL(3) = 0.0
    DO 170 LP170 = 1,NSED
       SEDAV = SEDLT(LP170) + DA * PSI(LP170)
       YIELD(LP170,3) = TSEDQ(LP170)
       IF (TSEDQ(LP170) .GT. SEDAV) YIELD(LP170,3) = SEDAV
       TYIEL(3) = TYIEL(3) + YIELD(LP170,3)
170 CONTINUE
    RETURN
    END
```

SUBROUTINE FRWRD (QIN, TIMIN, NEXQ)

```
      SUBROUTINE FRWRD (QIN,TIMIN,NEXQ)
C
C     THIS UNIT CALCULATES THE FINAL TIME OF A CHARACTERISTIC LINE
C     GIVEN THE INITIAL TIME.  THE METHOD OF CHARACTERISTICS IS USED
C     FOR THE SOLUTION.  FINAL TIMES ARE CALCULATED FOR THE INITIAL
C     TIMES GIVEN IN THE TIMIN ARRAY.
C
C     PARAMETER DEFINITONS.
C
C        ALP   = A IN Q=A*Y**B.
C        BET   = B IN Q=A*Y**B.
C        PLNGH = SLOPE LENGTHS OF THE SURFACE BEING ROUTED.
C        KPLAN = INDEX OF THE PLANE IN THE ANWAT UNIT.
C        QIN   = ARRAY OF EXCESS RAINFALL (OR LATERAL INFLOW FOR A
C                CHANNEL).
C        TIMIN = ARRAY OF FINAL INTERVAL TIMES CORRESPONDING TO THE
C                QIN ARRAY.
C        NEXQ  = NUMBER OF ELEMENTS IN TIMIN AND QIN ARRAYS.
C        OUTTM = ARRAY CONTAINING THE FINAL TIMES OF THE CHARACTERIS-
C                TIC LINES STARTING WITH THE TIMES GIVEN IN THE TIMIN
C                ARRAY.
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1       GRNCV(2)     , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2       PSI(10)      , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3       YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1       B1RS         , BET         , CHDOF       , CRS         ,
     2       DCOEF        , DOF         , DPOW        , DTIM        ,
     3       FTIM         , IEF16       , IEVNT       , IPLAN       ,
     4       ISTAT        , ISTOR       , ISTRM       , KPLAN       ,
     5       NEX          , NOPL        , NPL         , NQ          ,
     6       NRAIN        , NSED        , NTOT1       , NUM         ,
     7       NUMP         , NWS         , QT          , RSTNC       ,
     8       TADCK        , TAREA       , THPF        , TRVOL       ,
     9       VISCO        , VOLUM       , XN
      DIMENSION             QIN(200)    , TIMIN(200)
```

```
      IFNAL = NEXO - 2
      DO 100 LP100 = 1,200
         OUTTM(LP100) = 0.0
  100 CONTINUE
C
C     THIS LOOP ITERATES THE CHARACTERISTIC LINES. INDEX LP150 SELECTS
C     THE APPROPRIATE TIME OF ORIGIN, TIMIN(LP150).  THIS IS THE BEGIN-
C     NING OF THE CHARACTERISTIC, OR THE TIME AT THE UPSTREAM BOUNDARY.
C
      DO 150 LP150 = 1,IFNAL
C
C     DX IS THE INCREMENTAL DISTANCE ALONG THE PLANE DURING A INTERVAL
C     OF RAINFALL AT A CONSTANT INTENSITY.
C
C     X IS THE DISTANCE DOWN THE PLANE FROM THE UPSTREAM BOUNDARY.
C
C     DEPTH IS THE DEPTH IN THE CASE OF OVERLAND FLOW AND THE AREA IN
C     THE CASE OF CHANNEL FLOW AT X.
C
         DX = 0.0
         X = 0.0
         DEPTH = 0.0
C
C     THIS LOOP ITERATES THE EXCESS INCREMENTS UNTIL THE DOWNSTREAM
C     BOUNDARY IS REACHED.
C
         DO 140 LP140 = LP150,IFNAL
            DT = TIMIN(LP140 + 1) - TIMIN(LP140)
            IF (QIN(LP140 + 1) .EQ. 0.0) GO TO 110
            DEPTH = DEPTH + QIN(LP140 + 1) * DT
            DX = (ALP/QIN(LP140 + 1)) * (DEPTH *  * BET - (DEPTH - QIN(L
     1      P140 + 1) * DT) *  * BET)
            X = X + DX
            GO TO 120
  110       DX = ALP * BET * (DEPTH *  * (BET - 1.0)) * DT
            X = X + DX
C
C     COMPARE X AND THE SLOPE LENGTH (PLNGH) TO DETERMINE IF THE
C     CHARACTERISTIC HAS REACHED THE DOWNSTREAM BOUNDARY.  IF IT HAS
C     REACHED THE BOUNDARY, THE UNIT BRANCHES OUT OF THE LOOP AND CAL-
C     CULATES OUTTM.
C
  120       IF (X .LT. PLNGH(KPLAN)) GO TO 140
            X = X - DX
            DEPTH = DEPTH - QIN(LP140 + 1) * DT
            IF (QIN(LP140 + 1) .EQ. 0.0) GO TO 130
            DELT = (((PLNGH(KPLAN) - X) * QIN(LP140 + 1)/ALP + DEPTH *
     1      * BET) *  * (1.0/BET) - DEPTH)/QIN(LP140 + 1)
            OUTTM(LP150) = DELT + TIMIN(LP140)
            DEPTH = DEPTH + QIN(LP140 + 1) * DELT
            GO TO 150
  130       OUTTM(LP150) = (PLNGH(KPLAN) - X)/(ALP * BET * (DEPTH *  * (
     1      BET - 1.0))) + TIMIN(LP140)
            GO TO 150
  140    CONTINUE
         OUTTM(LP150) = (PLNGH(KPLAN) - X)/(ALP * BET * (DEPTH *  * (BET
     1    - 1.0))) + TIMIN(IFNAL)
  150 CONTINUE
      OUTTM(NEXO - 1) = 1.0E30
      RETURN
      END
```

D-88

SUBROUTINE INDEX (TIME, L, NEXQ, TIMIN)

```
      SUBROUTINE INDEX (TIME,L,NEXQ,TIMIN)
C
C     THIS UNIT LOCATES WHICH INFLOW TIME INCREMENT (L) CONTAINS A
C     GIVEN TIME (TIME).
C
C     PARAMETER DEFINITIONS.
C
C        TIME  = TIME OF INTEREST.
C        L     = INDEX OF TIMIN ARRAY CONTAINING THE 'TIME'.
C        NEXQ  = NUMBER OF INFLOW TIME INCREMENTS.
C        TIMIN = ARRAY OF INFLOW TIME INCREMENTS (SECONDS).
C
      DIMENSION              TIMIN(200)
      DO 100 LP100 = 1,NEXQ
         L = LP100
         IF (TIME .LE. TIMIN(LP100)) GO TO 110
  100 CONTINUE
      L = NEXQ + 1
  110 CONTINUE
      RETURN
      END
```

SUBROUTINE INEXC

```
      SUBROUTINE INEXC
C
C     THIS UNIT INPUTS THE DATA ON THE FILE EXCXXX.
C
C     PARAMETER DEFINITIONS.
C
C        IEF16 = 1 IF THE END OF FILE OF THE FILE EXCXXX HAS BEEN
C                REACHED, AND = 0 OTHERWISE.
C        KPLAN = INDEX OF THE PLANE IN THE ANWAT UNIT.
C
      COMMON /ARAYS/         CANCV(2)     , DATEI(5)     , DMBI(10)     ,
     1        GRNCV(2)     , OUTTM(200)   , PLNGH(3)     , POROS(2)     ,
     2        PSI(10)      , SLOPE(3)     , TYIEL(3)     , Y(200)       ,
     3        YIELD(10,3)
      COMMON /BLOCK/         AIRS         , ADW          , ALP          ,
     1        BIRS         , BET          , CHDOF        , CRS          ,
     2        DCOEF        , DOF          , DPOW         , DTIM         ,
     3        FTIM         , IEF16        , IEVNT        , IPLAN        ,
     4        ISTAT        , ISTOR        , ISTRM        , KPLAN        ,
     5        NEX          , NOPL         , NPL          , NQ           ,
     6        NRAIN        , NSED         , NTOT1        , NUM          ,
     7        NUMP         , NWS          , QT           , RSTNC        ,
     8        TAOCK        , TAREA        , TMPF         , TRVOL        ,
     9        VISCO        , VOLUM        , XN
      COMMON /EMBLK/         ADJ(50)      , DAYI(366,5)  , EXCES(200)   ,
     1        EXCST(200)   , IPRNT(50)    , ISEG(50)     , ITYPE(50)    ,
     2        NUEVT(366)   , QL(200,2)    , QLT(200)     , QLTIM(200)   ,
     3        QOUT(200)    , RAIND(200)   , RAINT(200)   , VOLU(366)
      IEF16 = 0
C
C     INITIALIZE EXCESS DATA.
C
      DO 100 LP100 = 1,200
         EXCES(LP100) = 0.0
         EXCST(LP100) = 0.0
  100 CONTINUE
C
C     INPUT DATA FROM THE FILE EXCXXX.  VOLUM IS IN CENTIMETERS. GRNCV
C     IS THE GROUND COVER,AND CANCV IS THE CANOPY COVER.
C
      READ (16) IDUM1,ISTOR,IEVNT,(DATEI(IMPD1),IMPD1 = 1,5),VOLUM,NEX,(
     1EXCES(IMPD2),EXCST(IMPD2),IMPD2 = 1,NEX),DUM2,IDUM3,GRNCV(KPLAN),
     2CANCV(KPLAN)
      IF (EOF(16) .NE. 0.0) GO TO 120
C
C     FIND EXCESS DATA IN INCHES PER MINUTE AND WITH UNITS OF TIME IN
C     MINUTES.
C
      DO 110 LP110 = 1,NEX
         EXCES(LP110) = EXCES(LP110)/2.54
  110 CONTINUE
      RETURN
  120 IEF16 = 1
      RETURN
      END
```

SUBROUTINE INGEO

```
      SUBROUTINE INGEO
C
C     THIS UNIT INPUTS WATERSHED DATA FOR THE UNIT ANWAT.  THE DATA IS
C     INPUT FROM THE FILE GEOXXX.
C
C     PARAMETER DEFINITIONS.
C
C        IPLAN = INDICATOR OF WHETHER 1-PLANE OR 2-PLANES AND
C                1-CHANNEL IS IN THIS PARTICULAR WATERSHED.
C        PLNGH = ARRAY OF PLANE & CHANNEL LENGTHS.
C        SLOPE = ARRAY OF PLANE & CHANNEL SLOPES.
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1        GRNCV(2)    , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2        PSI(10)     , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTWC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
      DIMENSION             D(11)       , P(11)
C
C     INPUT NUMBER OF PLANES.
C
      READ (1,130) IPLAN
      DO 120 LP120 = 1,IPLAN
         READ (1,140) POROS(LP120)
C
C     INPUT SLOPE AND LENGTH OF EACH PLANE.
C
         READ (1,140) SLOPE(LP120),PLNGH(LP120)
         READ (1,140) SLOPE(3),PLNGH(3)
C
C     CONVERT LENGTHS FROM METERS TO FEET.
C
         PLNGH(LP120) = PLNGH(LP120)/0.3048
         PLNGH(3) = PLNGH(3)/0.3048
C
C     INPUT NUMBER OF RAINFALL INCREMENTS, TEMPERATURE OF WATER, AND
C     CHANNEL DARCEY-WIESBACH RESISTANCE FACTOR.
C
         READ (1,140) CRS,XN,A1RS,B1RS
         READ (1,140) ADW,DCOEF,DPOW,DOF,CHDOF,TAOCK,NSED
         DO 100 LP100 = 1,NSED
            READ (1,150) D(LP100),P(LP100)
  100    CONTINUE
         NSED = NSED - 1
         DO 110 LP110 = 1,NSED
            PSI(LP110) = P(LP110 + 1) - P(LP110)
            DMBI(LP110) = (D(LP110 + 1) * D(LP110)) *  * 0.5/304.8
  110    CONTINUE
  120 CONTINUE
      RETURN
  130 FORMAT (I10)
  140 FORMAT (6F10.0,I10)
  150 FORMAT (2E20.5)
      END
```

D-90

SUBROUTINE INRAI

```
      SUBROUTINE INRAI
C
C     THIS UNIT INPUTS DATA FROM THE FILE RAIXXX.
C
C     PARAMETER DEFINITIONS.
C
C        RAIND = ARRAY OF RAINFALL INTENSITIES FOR THE STORM.
C        RAINT = ARRAY OF FINAL TIMES CORRESPONDING TO THE RAINFALL
C                INTENSITIES.
C        NRAIN = NUMBER OF RAINFALL INCREMENTS (INTENSITIES).
C        TMPF  = TEMPERATURE OF WATER.
C
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TADCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
      COMMON /EMBLK/        ADJ(50)     , DAYI(366,5) , EXCES(200)  ,
     1        EXCST(200)  , IPRNT(50)   , ISEG(50)    , ITYPE(50)   ,
     2        NUEVT(366)  , QL(200,2)   , QLT(200)    , QLTIM(200)  ,
     3        QOUT(200)   , RAIND(200)  , RAINT(200)  , VOLU(366)
C
C     INPUT DATA FROM THE FILE RAIXXX.
C     FIND THE PLANE NUMBER (ISTAT) AND THE STORM NUMBER (ISTRM).
C     FIND THE NUMBER OF RAINFALL INCREMENTS (NRAIN) AND THE WATER
C     TEMPERATURE (TMPF) IN DEGREES CELSIUS.
C
      READ (2) ISTAT,ISTRM,NRAIN,TMPF,(RAIND(IMPD1),RAINT(IMPD1),IMPD1 =
     11,NRAIN)
C
C     FIND THE RAINFALL HYETOGRAPH.  CONVERT RAINFALL INTENSITY FROM
C     CENTIMETERS PER HOUR TO INCHES PER MINUTE.
C
      DO 100 LP100 = 1,NRAIN
         RAIND(LP100) = RAIND(LP100)/(60.0 * 2.54)
  100 CONTINUE
C
C     CONVERT WATER TEMPERATURE FROM DEGREES CELSIUS TO DEGREES
C     FARENHEIT.
C
      TMPF = (9.0/5.0) * TMPF + 32.0
      RETURN
      END
```

SUBROUTINE INTGR (T1, TIME, DEPTH, QIN, TIMIN, NEXQ)

```
      SUBROUTINE INTGR (T1,TIME,DEPTH,QIN,TIMIN,NEXQ)
C
C     THIS UNIT (INTGR) INTEGRATES THE EXCESS RAINFALL (OR INFLOW IN
C     THE CASE OF A CHANNEL) HISTOGRAM BETWEEN AN INITIAL TIME (T1)
C     AND A FINAL TIME (TIME).
C
C     PARAMETER DEFINITIONS.
C
```

D-91

```
C        T1    = INITIAL TIME OF CHARACTERISTIC.
C        TIME  = FINAL TIME OF CHARACTERISTIC.
C        DEPTH = AREA BETWEEN T1 AND TIME OF QIN ARRAY.
C        QIN   = ARRAY BEING INTEGRATED.
C        TIMIN = ARRAY OF FINAL TIMES CORRESPONDING TO THE
C                QIN ARRAY.
C        NEXQ  = NUMBER OF ELEMENTS IN QIN AND TIMIN ARRAYS.
C
      DIMENSION            QIN(200)    , TIMIN(200)
C
C     INITIALIZE DUMMY VARIABLE WHICH IS USED TO STORE INTERMEDIATE
C     ANSWERS.
C
      CUM = 0.0
C
C     FIND INITIAL TIME INCREMENT.
C
      DO 100 LP100 = 2,NEXQ
         IF (T1 .LT. TIMIN(LP100)) GO TO 110
  100 CONTINUE
  110 INT = LP100
      IF (INT .GT. NEXQ) INT = NEXQ
C
C     FIND FINAL TIME INCREMENT.
C
      DO 120 LP120 = INT,NEXQ
         IF (TIME .GE. TIMIN(LP120)) GO TO 120
         IFIN = LP120
         GO TO 130
  120 CONTINUE
      IFIN = NEXQ
C
C     FIND AREA INBETWEEN INITIAL AND FINAL TIME INCREMENTS.
C
  130 DO 140 LP140 = INT,IFIN
         CUM = CUM + (TIMIN(LP140) - TIMIN(LP140 - 1)) * QIN(LP140)
  140 CONTINUE
C
C     CORRECT INTERMEDIATE ANSWER BY SUBTRACTING THE AREAS WHICH
C     SHOULD NOT BE INCLUDED.
C
      IF (T1 .EQ. 0.0) GO TO 150
      CUM = CUM - (T1 - TIMIN(INT - 1)) * QIN(INT)
  150 IF (TIME .GE. TIMIN(NEXQ)) GO TO 160
      CUM = CUM - (TIMIN(IFIN) - TIME) * QIN(IFIN)
C
C     SET VALUE OF FINAL ANSWER.
C
  160 DEPTH = CUM
      RETURN
      END
```

SUBROUTINE OUTPT (K1)

```
      SUBROUTINE OUTPT (K1)
C
C     THIS UNIT IS FOR THE OUTPUT AND DISPLAY OF INPUT DATA AND
C     RESULTS.
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1        GRNCV(2)    , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2        PSI(10)     , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
```

```
     5        NEX          , NOPL        , NPL         , NQ          ,
     6        NRAIN        , NSED        , NTOT1       , NUM         ,
     7        NUMP         , NWS         , QT          , RSTNC       ,
     8        TAOCK        , TAREA       , TMPF        , TRVOL       ,
     9        VISCO        , VOLUM       , XN
      COMMON /EMBLK/         ADJ(50)     , DAYI(366,5) , EXCES(200)  ,
     1        EXCST(200)   , IPRNT(50)   , ISEG(50)    , ITYPE(50)   ,
     2        NUEVT(366)   , QL(200,2)   , QLT(200)    , QLTIM(200)  ,
     3        QOUT(200)    , RAIND(200)  , RAINT(200)  , VOLU(366)
      DIMENSION              QMET(200)   , YIELM(10)
C
C     CONVERT FROM ENGLISH UNITS TO METRIC UNITS FOR OUTPUT.
C
      TAREM = TAREA * 43560.0/(10.7639 * 1.0E4)
      TRVOM = TRVOL * 43560.0/35.315
      TYIEM = TYIEL(KPLAN) * 0.453
      QTM = QT * (0.3048 *  * 3.0) * 43560.0
      FAC = 0.453
      IF (IPLAN .EQ. 1) FAC = FAC * 0.3048
      DO 100 LP100 = 1,NSED
         YIELM(LP100) = YIELD(LP100,KPLAN) * FAC
         DMBI(LP100) = DMBI(LP100) * 304.8
  100 CONTINUE
C
C     OUTPUT THE RESULTS TO THE LINE PRINTER.
C
      WRITE (6,120)
      WRITE (6,130) ISEG(K1)
      WRITE (6,140) TAREM,TRVOM,QTM,TYIEM
      WRITE (6,150)
      WRITE (6,160)
      WRITE (6,170) (DMBI(IMPD1),YIELM(IMPD1),IMPD1 = 1,NSED)
      WRITE (6,180)
      DO 110 LP110 = 2,NUM
         TIME = FLOAT (LP110 - 1) * DTIM/60.0
         QMET(LP110) = QOUT(LP110)/35.315
         WRITE (6,190) TIME,QMET(LP110)
  110 CONTINUE
      RETURN
  120 FORMAT (//////////)
  130 FORMAT (20X,28HTHE RESULTS FOR UNIT NUMBER:,19X,I3)
  140 FORMAT (20X,27HTHE TOTAL AREA IN HECTARES:,11X,E12.5/,20X,35HTHE T
     1OTAL RAINFALL IN CUBIC METERS:,3X,E12.5,/,20X,36HTHE TOTAL DISCHAR
     2GE IN CUBIC METERS:,2X,E12.5,/,20X,38HTHE TOTAL SEDIMENT YIELD IN
     3KILOGRAMS:,E12.5///)
  150 FORMAT (20X,74H(NOTE:  THE FOLLOWING VALUES ARE PER METER WIDTH, I
     1F THE UNIT IS A PLANE.))
  160 FORMAT (/20X,27HTHE SEDIMENT YIELD BY SIZES,/,20X,10HSIZE IN MM,8X
     1,9HKILOGRAMS)
  170 FORMAT (20X,E12.5,3X,E12.5)
  180 FORMAT (////20X,16HFINAL HYDROGRAPH,//28X,4HTIME,6X,9HDISCHARGE,/,
     126X,6H(MIN.),10X,5H(CMS))
  190 FORMAT (24X,F8.2,3X,E12.5)
      END
```

SUBROUTINE OXCWR

```
      SUBROUTINE OXCWR
C
C     THIS UNIT OUTPUTS VARIABLE VALUES TO THE FILE OXCXXX.
C
C     PARAMETER DEFINITIONS.
C
C        KPLAN = INDEX OF THE PLANE IN THE ANWAT UNIT.
C
      COMMON /ARAYS/         CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1        GRNCV(2)     , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2        PSI(10)      , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3        YIELD(10,3)
```

```
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
C
C     CONVERT VALUES TO METRIC SYSTEM FROM ENGLISH SYSTEM.
C
      PA = PLNGH(KPLAN) * 0.3048
      PB = PLNGH(3) * 0.3048
      WRITE (17,100) SLOPE(KPLAN),PA,RSTNC,PB
      RETURN
  100 FORMAT (4F12.5)
      END
```

SUBROUTINE PLANE

```
      SUBROUTINE PLANE
C
C     THIS UNIT (PLANE) CALCULATES THE SEDIMENT YIELD BY SIZE FOR THE
C     PLANE UNITS.
C
C     PARAMETER DEFINITIONS.
C
C        KPLAN = INDEX OF THE PLANE IN THE ANWAT UNIT.
C
C     ##############################################################
C     USER WRITTEN EXTERNAL :   POWER
C     ##############################################################
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1        GRNCV(2)    , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2        PSI(10)     , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
      COMMON /EMBLK/        ADJ(50)     , DAYI(366,5) , EXCES(200)  ,
     1        EXCST(200)  , IPRNT(50)   , ISEG(50)    , ITYPE(50)   ,
     2        NUEVT(366)  , QL(200,2)   , QLT(200)    , QLTIM(200)  ,
     3        QOUT(200)   , RAIND(200)  , RAINT(200)  , VOLU(366)
      DIMENSION             SEDQ(10)    , TSEDQ(10)
C
C     CALCULATE DECIMAL PERCENT OF GROUND AND CANOPY COVER.
C
      CG = GRNCV(KPLAN)/100.0
      CC = CANCV(KPLAN)/100.0
C
C     INITIALIZE VARIABLES.
C
      TRANC = 0.0
      SUMSD = 0.0
      TIME = 0.0
      DO 100 LP100 = 1,NSED
         SEDQ(LP100) = 0.0
         TSEDQ(LP100) = 0.0
  100 CONTINUE
C
C     CALCULATE THE AMOUNT OF SEDIMENT DETACHED FROM RAINFALL.
C
      AR = 1.0 - CG - CC + CC * CG
      DAREA = AR * PLNGH(3) * PLNGH(KPLAN)
      WTFAC = DAREA * (1.0 - POROS(KPLAN)) * 2.65 * 62.4/12.0
```

D-94

```
      DO 110 LP110 = 2,NRAIN
         DQ = DCOEF * (RAIND(LP110) * 60.0) *  * DPOW
         SUMSD = SUMSD + DQ * (RAINT(LP110) - RAINT(LP110 - 1))/60.0
  110 CONTINUE
      SUMSD = SUMSD * WTFAC
C
C     THIS LOOP CALCULATES THE TRANSPORTING CAPACITY FOR THE CALCULA-
C     TED DISCHARGE AT EACH TIME INCREMENT FOR EACH SIZE.
C
      DO 160 LP160 = 2,200
         TIME = TIME + DTIM
         IF (TIME .GT. FTIM) GO TO 170
         IF (QL(LP160,KPLAN) .LE. 0.0) GO TO 160
C
C     CALCULATE THE DEPTH OF FLOW AND MEAN VELOCITY.
C
         DEPTH = (QL(LP160,KPLAN) * RSTNC * VISCO/(257.6 * SLOPE(KPLAN))
     1   ) *  * (1.0/3.0)
         VMEAN = QL(LP160,KPLAN)/DEPTH
C
C     EFFECTIVE SHEAR STRESS.
C
         TAO = 0.24225 * 45.0 * VISCO * QL(LP160,KPLAN)/(DEPTH *  * 2.0)
         SUMPS = 0.0
C
C     THIS LOOP CALCULATES THE SUSPENDED AND BEDLOAD SEDIMENT TRANS-
C     PORT CAPACITY FOR EACH SEDIMENT SIZE.
C
         DO 150 LP150 = 1,NSED
C
C     CRITICAL SHEAR STRESS.
C
            TAOC = 102.96 * TAOCK * DMBI(LP150)
            IF (TAO .GT. TAOC) GO TO 120
            SEDQ(LP150) = 0.0
            SUSP = 0.0
            GO TO 140
C
C     CALCULATE THE BEDLOAD TRANSPORT BY MEYER-PETER,MUELLER EQUATION.
C
  120       SEDQ(LP150) = (12.85/1.392) * (TAO - TAOC) *  * (1.5)
C
C     SHEAR VELOCITY.
C
            SV = SQRT(62.4 * DEPTH * SLOPE(KPLAN)/1.938)
C
C     FALL VELOCITY.
C
            FVB = (SQRT(36.064 * DMBI(LP150) *  * 3.0 + 36.0 * VISCO *
     1      * 2.0) - 6.0 * VISCO)/DMBI(LP150)
            IF (DMBI(LP150) .LE. 0.0002) FVB = 2.9517 * DMBI(LP150) *  *
     1       2.0/VISCO
C
C     CALCULATE THE PARAMETERS FOR EINSTIEN'S SUSPENDED SEDIMENT LOAD
C     APPROXIMATION.
C
            ZR = FVB/(0.4 * SV)
            AR = 2.0 * DMBI(LP150)/DEPTH
            SUSMX = 1.0/AR
            IF ((ZR .GT. 5.5) .OR. (AR .GT. 0.5)) GO TO 130
C
C     EVALUATE J1 AND J2.
C
            CONV = 1.0E - 2
            CALL POWER (ZR,AR,XJ1,XJ2,CONV)
            P = AR *  * (ZR - 1.0)/(11.6 * (1. - AR) *  * ZR)
            BMV = 2.5 + VMEAN/SV
            SUSP = P * (BMV * XJ1 + 2.5 * XJ2)
            IF (SUSP .LT. 0.0) SUSP = 0.0
            IF (SUSP .GT. SUSMX) SUSP = SUSMX
            GO TO 140
  130       SUSP = 0.0
```

D-95

```
C
C     UPDATE THE SEDIMENT TRANSPORT CAPACITY FOR THE SUSPENDED LOAD
C     FOR THIS SIZE. ALSO UPDATE THE TOTAL TRANSPORT CAPACITY FOR THIS
C     SIZE AND THE CAPACTY FOR ALL SIZES AT THIS TIME INTERVAL.
C
  140       SEDQ(LP150) = (1.0 + SUSP) * SEDQ(LP150) * PSI(LP150)
            TSEDQ(LP150) = TSEDQ(LP150) + SEDQ(LP150) * PLNGH(3) * DTIM
            SUMPS = SUMPS + SEDQ(LP150)
  150    CONTINUE
C
C     UPDATE THE TOTAL SEDIMENT TRANSPORT CAPACITY FOR ALL SIZES.
C
         TRANC = TRANC + SUMPS * DTIM * PLNGH(3)
  160 CONTINUE
C
C     CALCULATE THE DETACHED SEDIMENT FROM CHANNEL FLOW.
C
  170 DA = DOF * (TRANC - SUMSD)
      IF (DA .LT. 0.0) DA = 0.0
      SUMSD = SUMSD + DA
C
C     THIS LOOP CALCULATES THE SEDIMENT YIELD FOR THE PLANE.  FIRST,
C     THE AVAILABLE SEDIMENT IS REDISTRIBUTED IN PROPORTION TO THE
C     PARENT MATERIAL, THEN THE NECESSARY COMPARISIONS ARE MADE.
C
      TYIEL(KPLAN) = 0.0
      DO 180 LP180 = 1,NSED
         SEDAV = PSI(LP180) * SUMSD
         YIELD(LP180,KPLAN) = TSEDQ(LP180)
         IF (TSEDQ(LP180) .GT. SEDAV) YIELD(LP180,KPLAN) = SEDAV
         TYIEL(KPLAN) = TYIEL(KPLAN) + YIELD(LP180,KPLAN)
  180 CONTINUE
      RETURN
      END
```

SUBROUTINE POWER (ZR, AR, XJ1, XJ2, CONV)

```
      SUBROUTINE POWER (ZR,AR,XJ1,XJ2,CONV)
C
C     THIS UNIT EVALUATES THE J1 AND J2 INTEGRALS IN THE EINSTEIN
C     SUSPENDED SEDIMENT LOAD APPROXIMATION.
C
C     PARAMETER DEFINITIONS.
C
C        AR    = THE SEDIMENT PER DEPTH PARAMETER.
C        CONV  = THE CONVERGENCE CRITERION.
C        XJ1   = THE J1 INTEGRAL.
C        XJ2   = THE J2 INTEGRAL.
C        ZR    = THE VELOCITY PARAMETER IN EINSTEIN'S EQUATION.
C        N     = THE ORDER OF THE APPROXIMATION PLUS ONE.
C
         N = 1
         XJ1 = 0.0
         XJ2 = 0.0
         ALG = ALOG (AR)
         C = 1.0
         D =  - ZR
         E = D + 1.0
         FN = 1.0
         AEX = AR *  * E
         GO TO 110
     100 N = N + 1
         C = C * D/FN
         D = E
         E = D + 1.0
         FN = FLOAT (N)
         AEX = AR *  * E
```

```
110 IF (ABS(E) .LE. 0.001) GO TO 120
    XJ1 = XJ1 + C * (1.0 - AEX)/E
    XJ2 = XJ2 + C * ((AEX - 1.0)/E * * 2 - AEX * ALG/E)
    GO TO 130
120 XJ1 = XJ1 - C * ALG
    XJ2 = XJ2 - 0.5 * C * ALG * * 2
130 IF (N .EQ. 1) GO TO 140
    CJ1 = ABS(1.0 - FJ1/XJ1)
    CJ2 = ABS(1.0 - FJ2/XJ2)
    IF ((CJ1 .LE. CONV) .AND. (CJ2 .LE. CONV)) GO TO 150
140 FJ1 = XJ1
    FJ2 = XJ2
    GO TO 100
150 CONTINUE
    RETURN
    END
```

SUBROUTINE QLAT

```
      SUBROUTINE QLAT
C
C     THIS UNIT IS USED ONLY IN THE 2-PLANES AND 1-CHANNEL CASE. IT
C     TOTALS THE LATERAL INFLOW INTO THE CHANNEL.
C
C     PARAMETER DEFINITIONS.
C
C        QL    = DOUBLE DIMENSION ARRAY CONTAINING THE OUTFLOWS FROM
C                EACH CHANNEL.
C        QLT   = ARRAY OF THE TOTAL LATERAL INFLOW.
C        QLTIM = ARRAY OF THE TIMES FOR THE TOTAL LATERAL INFLOW (QLT
C                ARRAY).
C        DTIM  = TIME INCREMENT USED (SECONDS).
C        NQ    = NUMBER OF ELEMENTS IN TIME ARRAY.
C
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHOOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
      COMMON /EMBLK/        ADJ(50)     , DAYI(366,5) , EXCES(200)  ,
     1        EXCST(200)  , IPRNT(50)   , ISEG(50)    , ITYPE(50)   ,
     2        NUEVT(366)  , QL(200,2)   , QLT(200)    , QLTIM(200)  ,
     3        QOUT(200)   , RAIND(200)  , RAINT(200)  , VOLU(366)
C
C     CALUCULATE THE TOTAL AVERAGE INFLOW OVER A GIVEN TIME PERIOD.
C
      QLT(1) = 0.0
      QLTIM(1) = 0.0
      DO 100 LP100= 2,NQ
         QLT(LP100) = (QL(LP100,1) + QL(LP100,2) + QL(LP100 - 1,1) + QL(
     1   LP100 - 1,2))/2.0
         QLTIM(LP100) = QLTIM(LP100 - 1) + DTIM
  100 CONTINUE
      NQ = NQ + 1
      QLTIM(NQ) = QLTIM(NQ - 1) + 1.0E30
      RETURN
      END
```

D-97

SUBROUTINE RESIS

```
      SUBROUTINE RESIS
C
C     THIS UNIT CALCULATES THE PARAMETERS A AND B IN THE EQUATION
C     Q=A*AREA**B.
C
      COMMON /ARAYS/        CANCV(2)    , DATEI(5)    , DMBI(10)    ,
     1        GRNCV(2)    , OUTTM(200)  , PLNGH(3)    , POROS(2)    ,
     2        PSI(10)     , SLOPE(3)    , TYIEL(3)    , Y(200)      ,
     3        YIELD(10,3)
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
C
C     DECIDE WHICH RESISTANCE TO USE.
C
      IF (CRS .NE. 0.0) GO TO 100
C
C     THIS IS FOR THE MANNINGS RESISTANCE.
C
      BET = (5.0 - 2.0 * B1RS)/3.0
      ALP = ((SLOPE(3) * 2.21)/(XN * XN * A1RS *  * (4.0/3.0))) *  * 0.5
      RETURN
C
C     THIS IS FOR THE CHEZY RESISTANCE.
C
  100 BET = (3.0 - B1RS)/2.0
      ALP = (SLOPE(3) * CRS * CRS/A1RS) *  * 0.5
      RETURN
      END
```

SUBROUTINE TEMP

```
      SUBROUTINE TEMP
C
C     THIS UNIT CORRECTS THE VISCOSITY AND THE HYDRAULIC CONDUCTIVITY
C     FOR TEMPERATURE VARIATIONS FROM THE ASSUMED TEMPERATURE OF 68
C     DEGREES (FARENHEIT).
C
C     PARAMETER DEFINTIONS.
C
C        TMPF  = TEMPERATURE IN DEGREES FARENHEIT.
C        VISCO = KINEMATIC VISCOSITY (SQUARE FEET PER SECOND).
C
      COMMON /BLOCK/        A1RS        , ADW         , ALP         ,
     1        B1RS        , BET         , CHDOF       , CRS         ,
     2        DCOEF       , DOF         , DPOW        , DTIM        ,
     3        FTIM        , IEF16       , IEVNT       , IPLAN       ,
     4        ISTAT       , ISTOR       , ISTRM       , KPLAN       ,
     5        NEX         , NOPL        , NPL         , NQ          ,
     6        NRAIN       , NSED        , NTOT1       , NUM         ,
     7        NUMP        , NWS         , QT          , RSTNC       ,
     8        TAOCK       , TAREA       , TMPF        , TRVOL       ,
     9        VISCO       , VOLUM       , XN
      DIMENSION             TE(10)      , V(10)
      DATA TE/32.,  40.,  50.,  60.,  68.,  80.,  90., 100., 120., 140./
     1 , V /1.93 ,1.66 ,1.41 ,1.22 ,1.09 , .93 , .826, .739, .609, .514/
C
C     CALCULATE NEW VISCOSITY BY INTERPOLATION.
C
      DO 100 LP100 = 1,10
         IF (TE(LP100) .LT. TMPF) GO TO 100
         IF (LP100 .EQ. 1) VISCO = V(1)
         IF (LP100 .EQ. 1) GO TO 110
         FAC1 = (TMPF - TE(LP100 - 1))/(TE(LP100) - TE(LP100 - 1))
         VISCO = V(LP100 - 1) + FAC1 * (V(LP100) - V(LP100 - 1))
         GO TO 110
  100 CONTINUE
  110 VISCO = VISCO * 0.00001
      RETURN
      END
```

D-92

PROGRAM USFSORT

```
      PROGRAM USFSORT
     1(INPUT,OUTPUT,TAPE3=65,TAPE4=65,TAPE7=65,TAPE8=65,TAPE12=65,TAPE13
     2=65,TAPE15=65)
C
C     THIS PROGRAM REARRANGES THE DATA ON TWO FILES AND PLACES THE DATA
C     ON FOUR FILES.
C
C     ################################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ################################################################
C
C     INPUT FILES
C        READ (7,FM)   = TA7XXX
C        READ (8,FM)   = TA8XXX
C        READ (15,FM)  = T15XXX
C
C     OUTPUT FILES
C        WRITE (3,FM)  = T03XXX
C        WRITE (4,FM)  = T04XXX
C        WRITE (12,FM) = T12XXX
C        WRITE (13,FM) = T13XXX
C
C     ################################################################
      DIMENSION              QARAY(200,20)              , SARAY(10,20),
     1        QT(20)
      REWIND 3
      REWIND 4
      REWIND 7
      REWIND 8
      REWIND 12
      REWIND 13
      REWIND 15
C
C     INPUT NUMBER OF STORM EVENTS.
C
      READ (15,61) NEVNT
      IF (NEVNT .LT. 1) GO TO 51
C
C     SET UP THE FILES FOR THE PROGRAM HCHNL.
C
      DO 41 LP41 = 1,NEVNT
         IREAD = 7
         IWRT1 = 3
         IWRT2 = 4
   11    READ (IREAD,71) NU,NUM1
         NUM = NUM1 - 1
         DO 21 LP21 = 1,NU
            READ (IREAD,81) NSED
            READ (IREAD,91) (SARAY(IMPD1,LP21),IMPD1 = 1,NSED)
            WRITE (IWRT2,91) (SARAY(IMPD2,LP21),IMPD2 = 1,NSED)
            READ (IREAD,91) QT(LP21)
            READ (IREAD,91) (QARAY(IMPD3,LP21),IMPD3 = 1,NUM)
   21    CONTINUE
         WRITE (IWRT1,91) (QT(IMPD4),IMPD4 = 1,NU)
         DO 31 LP31 = 1,NUM
            WRITE (IWRT1,91) (QARAY(LP31,IMPD5),IMPD5 = 1,NU)
   31    CONTINUE
         IF (IREAD .EQ. 8) GO TO 41
         IREAD = 8
         IWRT1 = 12
         IWRT2 = 13
         GO TO 11
   41 CONTINUE
C
C     TERMINATED THE PROGRAM NORMALLY.
C
   51 CONTINUE
      STOP
C
C     VARIOUS FORMATS.
C
   61 FORMAT (1X,I7)
   71 FORMAT (2I10)
   81 FORMAT (10X,I10)
   91 FORMAT (4E20.10)
      END
```

D-77

PROGRAM MCHNL

```
      BLOCK DATA
C
C     DECLARATION OF COMMON BLOCKS IN THE PROGRAM MCHNL.
C
      COMMON /ARAYS/        RA(3500)    , IA(110)
      COMMON /BLOCK/        RB(17)      , IB(7)
      END
      PROGRAM MCHNL
     1(INPUT,OUTPUT,TAPE3=65,TAPE4=65,TAPE9=65,TAPE10=65,TAPE12=65,TAPE1
     23=65,TAPE15=65,TAPE20=65,TAPE48=65,TAPE50=513,TAPE62=65,TAPE92=513
     3,TAPE98=INPUT,TAPE99=OUTPUT)
C
C     ****************************************************************
C     INPUT AND OUTPUT DICTIONARY.
C     ****************************************************************
C
C     INPUT FILES
C        READ (3,FM)   = T03XXX
C        READ (4,FM)   = T04XXX
C        READ (9,FM)   = F09XXX
C        READ (10,FM)  = F10XXX
C        READ (12,FM)  = T12XXX
C        READ (13,FM)  = T13XXX
C        READ (15,FM)  = T15XXX
C        READ (20,FM)  = QUPXXX
C        READ (98,FM)  = MCIXXX
C
C     OUTPUT FILES
C        WRITE (48,FM)  = SSMXXX
C        WRITE (50)     = QPKXXX
C        WRITE (62,FM)  = HYGXXX
C        WRITE (92)     = AMCXXX
C        WRITE (99,FM)  = LINE PRINTER
C
C     ****************************************************************
C
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1        ASUM        , BET         , BPER        , CPR         ,
     2        DT          , DTS         , DTX         , EPR         ,
     3        EPS         , IMAX        , MM          , NDX         ,
     4        NPL         , NSEG        , NUM         , NWS         ,
     5        QE          , QLAT        , QUP         , SSUM        ,
     6        YRSED
      READ (15,31) NEVNT
      WRITE (92) NEVNT
      YRSED = 0.0
      IF (NEVNT .LT. 1) GO TO 21
      DO 11 LP11 = 1,NEVNT
         WRITE (92) LP11
         REWIND 9
         REWIND 10
         CALL DATA1
         CALL TEMP1
         CALL INITL
         CALL ROUTE
   11 CONTINUE
   21 YRSED = YRSED/2.2046
      WRITE (48,41) YRSED
C
C     TERMINATE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
   31 FORMAT (1X,I7)
   41 FORMAT (2X,G30.10)
      END
```

SUBROUTINE CEASE (K, J)

```
      SUBROUTINE CEASE (K,J)
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)      , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)      , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)    , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)      , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)     , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)    , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)     , POROS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)    , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)     , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)  , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)    , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)      , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT         , ALP          , AREA         ,
     1        ASUM         , BET          , BPER         , CPR          ,
     2        DT           , DTS          , DTX          , EPR          ,
     3        EPS          , IMAX         , MM           , NDX          ,
     4        NPL          , NSEG         , NUM          , NWS          ,
     5        QE           , QLAT         , QUP          , SSUM         ,
     6        YRSED
      AREA = 0.0
      QE = 0.0
      DO 100 LP100 = 1,MM
         EGB(LP100) = GBUP(LP100) * DTX + BTEM(LP100) * A(K,J) + BLAT(LP
     1   100)
         RB(K,J,LP100) = 0.0
  100 CONTINUE
      RETURN
      END
```

SUBROUTINE CHINL (K, J)

```
      SUBROUTINE CHINL (K,J)
C
C     THIS PROGRAM UNIT CALCULATES CHANNEL INFILTRATION.
C
C     PARMETER DEFINITIONS.
C
C        SI     = INITIAL SATURATION OF CHANNEL SOIL.
C        SW     = WETTED SATURATION OF CHANNEL SOIL.
C        SUC    = AVERAGE SUCTION OF CHANNEL SOIL (INCHES).
C        POROS  = POROSITY OF SOIL.
C        WETK   = HYDRAULIC CONDUCTIVITY OF CHANNEL SOIL (INCHES PER
C                 HOUR).
C        SIN    = ACCUMALATED INFILTRATED VOLUME (CUBIC FEET).
C        QUP    = UPSTREAM FLOW (CUBIC FEET PER SECOND).
C        QLAT   = LATERAL INFLOW (CUBIC FEET PER SECOND PER FOOT).
C        DT     = LENGTH OF TIME INTERVAL (SECOND).
C        A      = PREVIOUS CROSS SECTIONAL AREA (SQUARE FEET).
C
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)      , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)      , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)    , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)      , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)     , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
```

```
     6        IUP(10,2)   , IWS(10,3)   , PBO(10,10)  , PB1(10,10)  ,
     7        PORB(10)    , POROS(10)   , Q(100)      , QDUM(10)    ,
     8        QOUT(200)   , QP(10,10)   , QPL(20)     , QTOUT(10)   ,
     9        QTPL(20)    , QTWS(10)    , QWS(10)     , RB(10,5,10) ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)      ,
     B        SIN(10,5)   , SLEN(10)    , SLOP(10,5)  , SLOP1(10)   ,
     C        SUC(10)     , SW(10)      , T(10)       , TIME(200)   ,
     D        TSEDO(10,10), VISCO(10)   , WETK(10)    , XN(10)      ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1        ASUM        , BET         , BPER        , CPR         ,
     2        DT          , DTS         , DTX         , EPR         ,
     3        EPS         , IMAX        , MM          , NDX         ,
     4        NPL         , NSEG        , NUM         , NWS         ,
     5        QE          , QLAT        , QUP         , SSUM        ,
     6        YRSED
C
C     CALCULATE CHANNEL TOP WIDTH AND DEPTH OF FLOW.
C
      TW = A2(K) * A(K,J) *  * B2(K)
      D = A(K,J)/TW
C
C     CALCULATE POTENTIAL INFILTRATION.
C
      AL = (SUC(K)/12.0 + D) * (SW(K) - SI(K)) * POROS(K)
      C1 = 2.0 * SIN(K,J) - WETK(K) * DTS
      C2 = 8.0 * WETK(K) * DTS * (AL + SIN(K,J))
      SEGL = SLEN(K)/FLOAT(NDX)
      DELF = (( - C1 + (C1 *  * 2 + C2) *  * 0.5)/2.0) * SEGL * TW
      IF (DELF .EQ. 0.0) GO TO 110
C
C     CALCULATE VOLUME OF AVAILABLE WATER.
C
      DELV = (QLAT * SEGL + QUP) * DTS
C
C     COMPARE POTENTIAL WITH AVAILABLE.
C
      IF (DELF .GE. DELV) GO TO 100
C
C     THIS IS THE CASE THAT THE TOTAL POTENTIAL IS INFILTRATED.
C
      SIN(K,J) = SIN(K,J) + DELF/(SEGL * TW)
      QLAT = QLAT - DELF/(SEGL * DTS)
      GO TO 110
C
C     THIS IS THE CASE THAT THE ALL THE AVAILABLE WATER IS INFILTRATED.
C
  100 SIN(K,J) = SIN(K,J) + DELV/(SEGL * TW)
      QLAT = 0.0
      QUP = 0.0
  110 CONTINUE
      RETURN
      END
```

SUBROUTINE DATA1

```
      SUBROUTINE DATA1
      COMMON /ARAYS/        A(10,10)    , A1(10)      , A2(10)      ,
     1        ADF(10)     , AGB(10)     , B1(10)      , B2(10)      ,
     2        BEX(10)     , BLAT(10)    , BTEM(10)    , C(10)       ,
     3        DELTS(10)   , DMB(10,10)  , DNB(10,10)  , EGB(10)     ,
     4        GBC(10)     , GBO(10,10)  , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)    , ICON(10)    , IPL(20,2)   , ISEG(10)    ,
     6        IUP(10,2)   , IWS(10,3)   , PBO(10,10)  , PB1(10,10)  ,
     7        PORB(10)    , POROS(10)   , Q(100)      , QDUM(10)    ,
     8        QOUT(200)   , QP(10,10)   , QPL(20)     , QTOUT(10)   ,
     9        QTPL(20)    , QTWS(10)    , QWS(10)     , RB(10,5,10) ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)      ,
```

D-100

```
     B        SIN(10,5)   , SLEN(10)    , SLOP(10,5)  , SLOP1(10)   ,
     C        SUC(10)     , SW(10)      , T(10)       , TIME(200)   ,
     D        TSEDO(10,10), VISCO(10)   , WETK(10)    , XN(10)      ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1        ASUM        , BET         , BPER        , CPR         ,
     2        DT          , DTS         , DTX         , EPR         ,
     3        EPS         , IMAX        , MM          , NDX         ,
     4        NPL         , NSEG        , NUM         , NWS         ,
     5        QE          , QLAT        , QUP         , SSUM        ,
     6        YRSED
      DIMENSION             D(10,11)    , PF(10,11)
      READ (98,160) DT,FTIM
      NUM = IFIX (FTIM/DT + 0.00001)
      READ (9,170) NPL,NWS,NSEG,NSED,IMAX
      NDX = 5
      MM = NSED - 1
      DO 100 LP100 = 1,NSEG
         READ (9,170) ISEG(LP100),(IWS(LP100,IMPD1),IMPD1 = 1,3),(IPL(LP
     1   100,IMPD2),IMPD2 = 1,2),(IUP(LP100,IMPD3),IMPD3 = 1,2),ICON(LP1
     2   00)
  100 CONTINUE
      READ (9,180) EPS
      DO 130 LP130 = 1,NSEG
         READ (10,190) LINE1
         READ (10,190) LINE2
         READ (10,180) SLEN(LP130),SLOP1(LP130),WETK(LP130),POROS(LP130)
     1   ,SI(LP130),SW(LP130),SUC(LP130)
         SLEN(LP130) = SLEN(LP130)/0.3048
         WETK(LP130) = WETK(LP130)/2.54
         SUC(LP130) = SUC(LP130)/2.54
         PORB(LP130) = 1.0 - POROS(LP130)
         READ (10,180) XN(LP130),C(LP130),T(LP130)
         T(LP130) = T(LP130) * 9.0/5.0 + 32.0
         READ (10,180) A1(LP130),B1(LP130),A2(LP130),B2(LP130),AGB(LP130
     1   ),BEX(LP130),ADF(LP130),DELTS(LP130)
         DO 110 LP110 = 1,NSED
            READ (10,180) D(LP130,LP110),PF(LP130,LP110)
  110    CONTINUE
         DO 120 LP120 = 1,MM
            PBO(LP130,LP120) = PF(LP130,LP120 + 1) - PF(LP130,LP120)
            DNB(LP130,LP120) = (D(LP130,LP120 + 1) * D(LP130,LP120)) *
     1      * 0.5
  120    CONTINUE
  130 CONTINUE
      DO 140 LP140 = 1,NPL
         READ (4,200) (SEDPL(LP140,IMPD4),IMPD4 = 1,MM)
  140 CONTINUE
      DO 150 LP150 = 1,NWS
         READ (13,200) (SEDWS(LP150,IMPD5),IMPD5 = 1,MM)
  150 CONTINUE
      READ (3,200) (QTPL(IMPD6),IMPD6 = 1,NPL)
      READ (12,200) (QTWS(IMPD7),IMPD7 = 1,NWS)
      RETURN
C
C     VARIOUS FORMATS.
C
  160 FORMAT (2(1X,F9.2))
  170 FORMAT (9I10)
  180 FORMAT (8F10.0)
  190 FORMAT (A2)
  200 FORMAT (4G20.10)
      END
```

SUBROUTINE DATA2

```
      SUBROUTINE DATA2
      COMMON /ARAYS/          A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)       , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)       , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)     , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)       , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)      , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)     , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)      , POROS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)     , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)      , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)   , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)     , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)       , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/          ALAT         , ALP          , AREA         ,
     1        ASUM          , BET          , BPER         , CPR          ,
     2        DT            , DTS          , DTX          , EPR          ,
     3        EPS           , TMAX         , MM           , NDX          ,
     4        NPL           , NSEG         , NUM          , NWS          ,
     5        QE            , QLAT         , QUP          , SSUM         ,
     6        YRSED
      READ (12,140) (QWS(IMPD1),IMPD1 = 1,NWS)
      DO 110 LP110 = 1,NWS
         DO 100 LP100 = 1,MM
         GBOWS(LP110,LP100) = SEDWS(LP110,LP100) * QWS(LP110)/(QTWS(L
     1   P110) * 43560.0 * 165.4)
  100    CONTINUE
  110 CONTINUE
      READ (3,140) (QPL(IMPD2),IMPD2 = 1,NPL)
      DO 130 LP130 = 1,NPL
         DO 120 LP120 = 1,MM
         GBOPL(LP130,LP120) = SEDPL(LP130,LP120) * QPL(LP130)/(QTPL(L
     1   P130) * 43560.0 * 165.4)
  120    CONTINUE
  130 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  140 FORMAT (4G20.10)
      END
```

SUBROUTINE INITL

```
      SUBROUTINE INITL
      COMMON /ARAYS/          A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)       , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)       , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)     , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)       , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)      , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)     , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)      , POROS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)     , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)      , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)   , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)     , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)       , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
```

```
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1        ASUM        , BET         , BPER        , CPR         ,
     2        DT          , DTS         , DTX         , EPR         ,
     3        FPS         , IMAX        , MM          , NDX         ,
     4        NPL         , NSEG        , NUM         , NWS         ,
     5        QE          , QLAT        , QUP         , SSUM        ,
     6        YRSED
C
C     INITIALIZE ENTIRE WATERSHED
C
      DO 110 LP110 = 1,MM
         DO 100 LP100 = 1,NSEG
            GBO(LP100,LP110) = 0.0
            PB1(LP100,LP110) = 0.0
            TSEDO(LP100,LP110) = 0.0
            DMB(LP100,LP110) = DNB(LP100,LP110)/304.8
  100    CONTINUE
         EGB(LP110) = 0.0
         GBC(LP110) = 0.0
         ZBL(LP110) = 0.0
         BTEM(LP110) = 0.0
  110 CONTINUE
      DO 140 LP140 = 1,NSEG
         Q(LP140) = 0.0
         WETK(LP140) = WETK(LP140)/43200.0
         QTOUT(LP140) = 0.0
         QDUM(LP140) = 0.0
         DO 130 LP130 = 1,NDX
            A(LP140,LP130) = 0.0
            QP(LP140,LP130) = 0.0
            SIN(LP140,LP130) = 0.0
            SLOP(LP140,LP130) = SLOP1(LP140)
            DO 120 LP120 = 1,MM
               SB(LP140,LP130,LP120) = 0.0
               RB(LP140,LP130,LP120) = 0.0
  120       CONTINUE
  130    CONTINUE
  140 CONTINUE
      RETURN
      END
```

SUBROUTINE OUTPT (K, IT)

```
      SUBROUTINE OUTPT (K,IT)
C
C     THIS PROGRAM UNIT HANDLES THE OUTPUT OF THE RESULTS.  ONLY THE
C     RESULTS AT THE DOWNSTREAM BOUNDARY ARE WRITTEN OUT.
C
      COMMON /ARAYS/        A(10,10)    , A1(10)      , A2(10)      ,
     1        ADF(10)     , AGB(10)     , B1(10)      , B2(10)      ,
     2        BEX(10)     , BLAT(10)    , BTEM(10)    , C(10)       ,
     3        DELTS(10)   , DMB(10,10)  , DNB(10,10)  , EGB(10)     ,
     4        GBC(10)     , GBO(10,10)  , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)    , ICON(10)    , IPL(20,2)   , ISEG(10)    ,
     6        IUP(10,2)   , IWS(10,3)   , PBO(10,10)  , PB1(10,10)  ,
     7        PORB(10)    , POROS(10)   , Q(100)      , QDUM(10)    ,
     8        QOUT(200)   , QP(10,10)   , QPL(20)     , QTOUT(10)   ,
     9        QTPL(20)    , QTWS(10)    , QWS(10)     , RB(10,5,10) ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)      ,
     B        SIN(10,5)   , SLEN(10)    , SLOP(10,5)  , SLOP1(10)   ,
     C        SUC(10)     , SW(10)      , T(10)       , TIME(200)   ,
     D        TSEDO(10,10), VISCO(10)   , WETK(10)    , XN(10)      ,
     E        ZBL(10)
```

```
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1       ASUM        , BET         , BPER        , CPR         ,
     2       DT          , DTS         , DTX         , EPR         ,
     3       EPS         , IMAX        , MM          , NDX         ,
     4       NPL         , NSEG        , NUM         , NWS         ,
     5       QE          , QLAT        , QUP         , SSUM        ,
     6       YRSED
      DIMENSION             QOUTM(200)  , TSEDM(10)
      QTOUT(K) = QTOUT(K) + (QDUM(K) + QUP) * 0.5 * DTS/43560.0
      DO 100 LP100 = 1,MM
         TSEDO(K,LP100) = TSEDO(K,LP100) + GBUP(LP100) * 165.4 * DTS
  100 CONTINUE
      QDUM(K) = QUP
      IF ((K .NE. NSEG) .OR. (IT .NE. NUM)) GO TO 150
      QTOUM = QTOUT(NSEG) * 43560.0/35.315
      DO 110 LP110 = 1,MM
         TSEDM(LP110) = TSEDO(NSEG,LP110) * 0.453
  110 CONTINUE
      DO 120 LP120 = 1,NUM
         QOUTM(LP120) = QOUT(LP120)/35.515
  120 CONTINUE
      WRITE (99,160) QTOUM
      WRITE (99,170) (DNB(NSEG,IMPD1),TSEDM(IMPD1),IMPD1 = 1,MM)
      WRITE (99,180)
      WRITE (99,170) (TIME(IMPD2),QOUTM(IMPD2),IMPD2 = 1,NUM)
      WRITE (92) NUM,(TIME(IMPD3),QOUTM(IMPD3),IMPD3 = 1,NUM)
      WRITE (62,190) NUM
      DO 130 LP130 = 1,NUM
         WRITE (62,200) TIME(LP130),QOUTM(LP130)
  130 CONTINUE
      DO 140 LP140 = 1,MM
         YRSED = YRSED + TSEDO(NSEG,LP140)
  140 CONTINUE
  150 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  160 FORMAT (10(/),20X,55HTHE RESULTS FOR THE DOWNSTREAM OUTLET OF THE
     1WATERSHED:,///,20X,33HTHE TOTAL RUNOFF IN CUBIC METERS:,E12.5///,2
     20X,28HTHE SEDIMENT YIELD BY SIZES:,//,20X,10HSIZE IN MM,8X,9HKILOG
     3RAMS)
  170 FORMAT (20X,E12.5,3X,E12.5)
  180 FORMAT (////,20X,16HFINAL HYDROGRAPH,//28X,4HTIME,6X,9HDISCHARGE,/
     1,26X,6H(MIN.),10X,5H(CMS))
  190 FORMAT (1X,I7)
  200 FORMAT (3X,E12.5,3X,E12.5)
      END
```

SUBROUTINE PERTG (K, DC, SUSP)

```
      SUBROUTINE PERTG (K,DC,SUSP)
      COMMON /ARAYS/        A(10,10)    , A1(10)      , A2(10)      ,
     1       ADF(10)     , AGB(10)     , B1(10)      , B2(10)      ,
     2       BEX(10)     , BLAT(10)    , BTEM(10)    , C(10)       ,
     3       DELTS(10)   , DMB(10,10)  , DNB(10,10)  , EGB(10)     ,
     4       GBC(10)     , GBO(10,10)  , GBOPL(20,10), GBOWS(10,10),
     5       GBUP(10)    , ICON(10)    , IPL(20,2)   , ISEG(10)    ,
     6       IUP(10,2)   , IWS(10,3)   , PBO(10,10)  , PB1(10,10)  ,
     7       PORB(10)    , PORDS(10)   , Q(100)      , QDUM(10)    ,
```

```
     8        QOUT(200)   , QP(10,10)   , QPL(20)     , QTOUT(10)   ,
     9        QTPL(20)    , QTWS(10)    , QWS(10)     , RB(10,5,10) ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)      ,
     B        SIN(10,5)   , SLEN(10)    , SLOP(10,5)  , SLOP1(10)   ,
     C        SUC(10)     , SW(10)      , T(10)       , TIME(200)   ,
     D        TSEDO(10,10), VISCO(10)   , WETK(10)    , XN(10)      ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1        ASUM        , BET         , BPER        , CPR         ,
     2        DT          , DTS         , DTX         , EPR         ,
     3        FPS         , IMAX        , MM          , NDX         ,
     4        NFL         , NSEG        , NUM         , NWS         ,
     5        QE          , QLAT        , QUP         , SSUM        ,
     6        YRSED
      DIMENSION             ZB(100)     , SUSP(10)
      SSUM = 0.0
      SSUMP = 0.0
      DMAX = 2.0 * DC
      IF (DC .GT. DMB(K,MM)) DMAX = 2.0 * DMB(K,MM)
      DO 100 LP100 = 1,MM
         ZB(LP100) = ZBL(LP100) + (1.0/(1.0 + SUSP(LP100))) * (GBUP(LP10
     1   0) + BLAT(LP100))/BPER
         SSUM = SSUM + ZBL(LP100)
         SSUMP = SSUMP + ZB(LP100)
  100 CONTINUE
      SUM = SSUMP
      SSSUM = FORB(K) * DMAX
      IF (SSUMP .GT. SSSUM) GO TO 120
      GDIFR = SSSUM - SSUMP
      DO 110 LP110 = 1,MM
         ZB(LP110) = ZB(LP110) + PBO(K,LP110) * GDIFR
  110 CONTINUE
      SUM = SSSUM
  120 DO 130 LP130 = 1,MM
         PB1(K,LP130) = ZB(LP130)/SUM
  130 CONTINUE
      RETURN
      END
```

SUBROUTINE POWR1 (ZR, AR, XJ1, XJ2, CONV)

```
      SUBROUTINE POWR1 (ZR,AR,XJ1,XJ2,CONV)
C
C     THIS UNIT EVALUATES THE J1 AND J2 INTEGRALS IN THE EINSTEIN
C     SUSPENDED SEDIMENT LOAD APPROXIMATION.
C
C     PARAMETER DEFINITIONS.
C
C        AR    = THE SEDIMENT PER DEPTH PARAMETER.
C        CONV  = THE CONVERGENCE CRITERION.
C        XJ1   = THE J1 INTEGRAL.
C        XJ2   = THE J2 INTEGRAL.
C        ZR    = THE VELOCITY PARAMETER IN EINSTEIN'S EQUATION.
C        N     = THE ORDER OF THE APPROXIMATION PLUS ONE.
C
      N = 1
      XJ1 = 0.0
      XJ2 = 0.0
      ALG = ALOG (AR)
      CR = 1.0
      D =  - ZR
      E = D + 1.0
      FN = 1.0
      AEX = AR *  * E
      GO TO 110
  100 N = N + 1
      CR = CR * D/FN
      D = E
      E = D + 1.0
      FN = FLOAT (N)
      AEX = AR *  * E
  110 IF (ABS(E) .LE. 0.001) GO TO 120
      XJ1 = XJ1 + CR * (1.0 - AEX)/E
      XJ2 = XJ2 + CR * ((AEX - 1.0)/E *  * 2 - AEX * ALG/E)
      GO TO 130
```

```
120 XJ1 = XJ1 - CR * ALG
    XJ2 = XJ2 - 0.5 * CR * ALG *  * 2
130 IF (N .EQ. 1) GO TO 140
    CJ1 = ABS(1.0 - FJ1/XJ1)
    CJ2 = ABS(1.0 - FJ2/XJ2)
    IF ((CJ1 .LE. CONV) .AND. (CJ2 .LE. CONV)) GO TO 150
140 FJ1 = XJ1
    FJ2 = XJ2
    GO TO 100
150 CONTINUE
    RETURN
    END
```

SUBROUTINE RESIS (K, J)

```
      SUBROUTINE RESIS (K,J)
      COMMON /ARAYS/        A(10,10)    , A1(10)       , A2(10)       ,
     1        ADF(10)     , AGB(10)     , B1(10)       , B2(10)       ,
     2        BEX(10)     , BLAT(10)    , BTEM(10)     , C(10)        ,
     3        DELTS(10)   , DMB(10,10)  , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)     , GBO(10,10)  , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)    , ICON(10)    , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)   , IWS(10,3)   , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)    , POROS(10)   , Q(100)       , QDUM(10)     ,
     8        QOUT(200)   , QP(10,10)   , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)    , QTWS(10)    , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)   , SLEN(10)    , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)     , SW(10)      , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)   , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT        , ALP          , AREA         ,
     1        ASUM        , BET         , BPER         , CPR          ,
     2        DT          , DTS         , DTX          , EPR          ,
     3        EPS         , IMAX        , MM           , NDX          ,
     4        NPL         , NSEG        , NUM          , NWS          ,
     5        QE          , QLAT        , QUP          , SSUM         ,
     6        YRSED
C
C     THIS PROGRAM UNIT CALCULATES THE PARAMETERS ALP AND BET IN THE
C     EQUATION:  AREA = ALP * Q *  * BET.
C
      IF (C(K) .NE. 0.0) GO TO 100
C
C     THIS IS FOR THE MANNINGS RESISTANCE.
C
      BET = 3.0/(5.0 - 2.0 * B1(K))
      ALP = (A1(K) *  * (4.0/3.0) * XN(K) *  * 2.0/(2.21 * SLOP(K,J))) *
     1  * (BET/2.0)
      GO TO 110
C
C     THIS IS FOR THE CHEZY RESISTANCE.
C
  100 BET = 2.0/(3.0 - B1(K))
      ALP = (A1(K)/(C(K) *  * 2.0 * SLOP(K,J))) *  * (BET/2.0)
  110 CONTINUE
      RETURN
      END
```

SUBROUTINE ROUTE

```
      SUBROUTINE ROUTE
      COMMON /ARAYS/        A(10,10)    , A1(10)       , A2(10)       ,
     1        ADF(10)     , AGB(10)     , B1(10)       , B2(10)       ,
     2        BEX(10)     , BLAT(10)    , BTEM(10)     , C(10)        ,
     3        DELTS(10)   , DMB(10,10)  , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)     , GBO(10,10)  , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)    , ICON(10)    , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)   , IWS(10,3)   , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)    , POROS(10)   , Q(100)       , QDUM(10)     ,
     8        QOUT(200)   , QP(10,10)   , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)    , QTWS(10)    , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)   , SLEN(10)    , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)     , SW(10)      , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)   , WETK(10)     , XN(10)       ,
     E        ZBL(10)
```

D-108

```
      COMMON /BLOCK/        ALAT        , ALP         , AREA        ,
     1        ASUM        , BET         , BPER        , CPR         ,
     2        DT          , DTS         , DTX         , EPR         ,
     3        EPS         , IMAX        , MM          , NDX         ,
     4        NFL         , NSEG        , NUM         , NWS         ,
     5        QE          , QLAT        , QUP         , SSUM        ,
     6        YRSED
      DIMENSION             APEAK(10,5) , QPEAK(10,5)
      DTS = DT * 60.0
      DTN = DTS * FLOAT (NDX)
      DO 110 LP110 = 1,5
         DO 100 LP100 = 1,10
            APEAK(LP100,LP110) = 0.0
            QPEAK(LP100,LP110) = 0.0
  100    CONTINUE
  110 CONTINUE
      DO 190 LP190 = 1,NUM
         CALL DATA2
         TIME(LP190) = FLOAT(LP190) * DT
C
C     COMPUTE AT TIME LP190 (T + DT)
C
         DO 180 LP180 = 1,NSEG
            K = ISEG(LP180)
            CPR = A1(K)
            EPR = B1(K)
            DTX = DTN/SLEN(K)
            CALL UPLAT (K)
            DO 170 LP170 = 1,NDX
               DO 120 LP120 = 1,MM
                  ZBL(LP120) = SB(K,LP170,LP120)
                  BTEM(LP120) = RB(K,LP170,LP120)
  120          CONTINUE
               IF (A(K,LP170) .LE. 1.0E - 04) GO TO 130
               CALL CHINL (K,LP170)
  130          ALAT = QLAT * DTS
               ASUM = ALAT + A(K,LP170) + DTX * QUP
C
C     DETERMINE THE COEFFICIENT AND THE EXPONENT IN A-Q RELATION.
C
               CALL RESIS (K,LP170)
               IF (ASUM .LE. 1.0E - 05) GO TO 140
               CALL WROUT (K,LP170)
               CALL TRNSP (K,LP170)
               IF (QE .GT. QPEAK(LP180,LP170)) APEAK(LP180,LP170) = AREA
               IF (QE .GT. QPEAK(LP180,LP170)) QPEAK(LP180,LP170) = QE
               CALL SROUT (K,LP170)
               GO TO 150
  140          CALL CEASE (K,LP170)
  150          A(K,LP170) = ALP * QE *  * BET
               QP(K,LP170) = QE
               QUP = QE
               SUMV = 0.0
               DO 160 LP160 = 1,MM
                  GBUP(LP160) = RB(K,LP170,LP160) * QE
                  SB(K,LP170,LP160) = ZBL(LP160) + EGB(LP160)/BPER
                  GBO(K,LP160) = GBUP(LP160)
                  SUMV = SUMV + EGB(LP160)
  160          CONTINUE
  170       CONTINUE
            Q(K) = QUP
            IF (K .EQ. NSEG) QOUT(LP190) = Q(K)
            CALL OUTPT (K,LP190)
  180    CONTINUE
  190 CONTINUE
      DO 210 LP210 = 1,NSEG
         DO 200 LP200 = 1,NDX
            QPRIO = QPEAK(LP210,LP200) * 0.02832
            APRIO = APEAK(LP210,LP200) * 0.0929
            WRITE (50) LP210,LP200,QPRIO,APRIO
  200    CONTINUE
  210 CONTINUE
      RETURN
      END
```

D-109

SUBROUTINE SROUT (K, J)

```
      SUBROUTINE SROUT (K,J)
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)      , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)      , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)    , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)      , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)     , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)    , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)     , POROS(10)    , Q(100)       , QNUM(10)     ,
     8        QOUT(200)    , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)     , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)  , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)    , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)      , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT         , ALP          , AREA         ,
     1        ASUM         , BET          , BPER         , CPR          ,
     2        DT           , DTS          , DTX          , EPR          ,
     3        EPS          , IMAX         , MM           , NDX          ,
     4        NPL          , NSEG         , NUM          , NWS          ,
     5        QE           , QLAT         , QUP          , SSUM         ,
     6        YRSED
C
C     CHECK THE AVAILABILITY OF BED MATERIAL LOAD.
C
      SGBUP = 0.0
      SRBE = 0.0
      SBTEM = 0.0
      SBLAT = 0.0
      DO 100 LP100 = 1,MM
         SGBUP = SGBUP + GBUP(LP100)
         SRBE = SRBE + RB(K,J,LP100)
         SBTEM = SBTEM + BTEM(LP100)
         SBLAT = SBLAT + BLAT(LP100)
  100 CONTINUE
      SEGB = (SGBUP - SRBE * QE) * DTX - SRBE * AREA + SBTEM * A(K,J) +
     1SBLAT
      IF (SEGB .GE. 0.0) GO TO 110
      EBTEM = SEGB + SSUM * BPER
      IF (EBTEM .GE. 0.0) GO TO 110
      DEP =  - ADF(K) * EBTEM/BPER
      GO TO 120
  110 DEP = 0.0
C
C     DETERMINATION OF AVAILABILITY FOR NEXT TIME STEP.
C
  120 DO 130 LP130 = 1,MM
         ZBL(LP130) = ZBL(LP130) + DEP * PBO(K,LP130)
  130 CONTINUE
      DO 140 LP140 = 1,MM
         EGB(LP140) = (GBUP(LP140) - RB(K,J,LP140) * QE) * DTX - RB(K,J,
     1   LP140) * AREA + BTEM(LP140) * A(K,J) + BLAT(LP140)
         IF (EGB(LP140) .GE. 0.0) GO TO 140
         EBTEM = EGB(LP140) + ZBL(LP140) * BPER
         IF (EBTEM .GE. 0.0) GO TO 140
         RB(K,J,LP140) = (ZBL(LP140) * BPER + BLAT(LP140) + BTEM(LP140)
     1   * A(K,J) + GBUP(LP140) * DTX)/(AREA + QE * DTX)
         IF (RB(K,J,LP140) .LE. 0.0) RB(K,J,LP140) = 0.0
         EGB(LP140) =  - ZBL(LP140) * BPER
  140 CONTINUE
      RETURN
      END
```

D-112

SUBROUTINE TEMP1

```
      SUBROUTINE TEMP1
C
C     THIS PROGRAM UNIT CORRECTS THE VISCOSITY AND HYDRAULIC
C     CONDUCTIVITY FOR TEMPERATURE VARIATIONS FROM THE ASSUMED
C     TEMPERATURE OF 68 DEGREES FARENHEIT.
C
C      PARAMETER DEFINTIONS.
C
C        T      = TEMPERATURE IN DEGREES FARENHEIT.
C        VISCO  = KINEMATIC VISCOSITY (SQUARE FEET PER SECOND).
C
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)     , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)     , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)   , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)     , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)    , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)   , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)    , POROS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)   , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)    , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10) , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)   , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)     , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT         , ALP          , AREA         ,
     1        ASUM        , BET          , BPER         , CPR          ,
     2        DT          , DTS          , DTX          , EPR          ,
     3        EPS         , IMAX         , MM           , NDX          ,
     4        NPL         , NSEG         , NUM          , NWS          ,
     5        QE          , QLAT         , QUP          , SSUM         ,
     6        YRSED
      DIMENSION             TE(10)       , V(10)
      DATA TE/32.,  40.,  50.,  60.,  68.,  80.,  90., 100., 120., 140./
     1 , V /1.93 ,1.66 ,1.41 ,1.22 ,1.09 , .93 , .826, .739, .609, .514/
C
C      CALCULATE NEW VISCOSITY BY INTERPOLATION.
C
      DO 110 LP110 = 1,NSEG
         DO 100 LP100 = 1,10
            IF (TE(LP100) .LT. T(LP110)) GO TO 100
            IF (LP100 .EQ. 1) VISCO(LP110) = V(1)
            IF (LP100 .EQ. 1) GO TO 110
            FAC1 = (T(LP110) - TE(LP100 - 1))/(TE(LP100) - TE(LP100 - 1)
     1      )
            VISCO(LP110) = V(LP100 - 1) + FAC1 * (V(LP100) - V(LP100 - 1
     1      ))
            GO TO 110
  100    CONTINUE
  110 CONTINUE
C
C      ADJUST THE HYDRAULIC CONDUCTIVITY.
C
      DO 120 LP120 = 1,NSEG
         FAC2 = VISCO(LP120)/1.09
         WETK(LP120) = WETK(LP120)/FAC2
         VISCO(LP120) = VISCO(LP120) * 0.00001
  120 CONTINUE
      RETURN
      END
```

SUBROUTINE TRNSP (K, J)

```
      SUBROUTINE TRNSP (K,J)
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)      , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)      , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)    , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)      , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)     , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)    , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)     , POROS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)    , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)     , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)  , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)    , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)      , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT         , ALP          , AREA         ,
     1        ASUM         , BET          , BPER         , CPR          ,
     2        DT           , DTS          , DTX          , EPR          ,
     3        EPS          , IMAX         , MM           , NDX          ,
     4        NPL          , NSEG         , NUM          , NWS          ,
     5        QE           , QLAT         , QUP          , SSUM         ,
     6        YRSED
      DIMENSION             SUSP(10)
C
C     DETERMINATION OF FLOW CONDITIONS, SUCH AS HYDRAULIC DEPTH, MEAN
C     VELOCITY, AND BOUNDARY SHEAR STRESS.
C
      AREA = ALP * QE *  * BET
      WEPER = CPR * AREA *  * EPR
      HYRAD = AREA/WEPER
      BPER = WEPER
      VMEAN = QE/AREA
      TAU = 62.4 * HYRAD * SLOP(K,J)
      SV = SQRT (TAU/1.9379)
      BMV = 2.5 + VMEAN/SV
      TAO = 0.2425 * 0.025 * VMEAN * VMEAN
      DC = TAO/(102.96 * DELTS(K))
      DO 150 LP150 = 1,MM
         TTEM = TAO - 102.96 * DELTS(K) * DMB(K,LP150)
C
C     BED MATERIAL LOAD ROUTING.
C
         IF (TTEM .LE. 0.0) GO TO 140
C
C     DETERMINATION OF RATIO OF SUSPENDED BED MATERIAL LOAD.
C
         IF (DMB(K,LP150) .GT. 0.0002) GO TO 100
         FVB = 2.9517 * DMB(K,LP150) *  * 2/VISCO(K)
         GO TO 110
  100    FVB = (SQRT(36.064 * DMB(K,LP150) *  * 3 + 36.0 * VISCO(K) *  *
     1    2) - 6.0 * VISCO(K))/DMB(K,LP150)
  110    ZR = FVB/(0.4 * SV)
         AR = 2.0 * DMB(K,LP150)/HYRAD
         SUSMX = 1.0/AR
         IF ((ZR .GT. 5.5) .OR. (AR .GT. 0.5)) GO TO 120
         CONV = 1.0E - 2
         CALL POWR1 (ZR,AR,XJ1,XJ2,CONV)
         P = AR *  * (ZR - 1.0)/(11.6 * (1.0 - AR) *  * ZR)
         SUSP(LP150) = P * (BMV * XJ1 + 2.5 * XJ2)
         IF (SUSP(LP150) .GT. SUSMX) SUSP(LP150) = SUSMX
         GO TO 130
  120    SUSP(LP150) = 0.0
C
C     DETERMINATION OF TRANSPORTING CAPACITY OF BED MATERIAL LOAD.
C
  130    GBC(LP150) = (1.0 + SUSP(LP150)) * WEPER * AGB(K) * TTEM *  * B
     1   EX(K)
         GO TO 150
```

```
140    RB(K,J,LP150) = 0.0
       SUSP(LP150) = 0.0
       GBC(LP150) = 0.0
150 CONTINUE
    CALL PERTG (K,DC,SUSP)
    DO 160 LP160 = 1,MM
       RB(K,J,LP160) = GBC(LP160) * PB1(K,LP160)/QE
160 CONTINUE
    RETURN
    END
```

SUBROUTINE UPLAT (K)

```
      SUBROUTINE UPLAT (K)
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)      , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)      , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)    , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)      , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)     , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)    , IWS(10,3)    , PBO(10,10)   , PB1(10,10)   ,
     7        PORB(10)     , POROS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)    , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)     , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)  , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)    , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)      , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT         , ALP          , AREA         ,
     1        ASUM         , BET          , BPER         , CPR          ,
     2        DT           , DTS          , DTX          , EPR          ,
     3        EPS          , IMAX         , MM           , NDX          ,
     4        NPL          , NSEG         , NUM          , NWS          ,
     5        QE           , QLAT         , QUP          , SSUM         ,
     6        YRSED
      DIMENSION             GBCON(10)    , GBLAT(10)
      QUP = 0.0
      QLAT = 0.0
      ALAT = 0.0
C
C     DETERMINE THE UPSTREAM INFLOW RATE.
C
      DO 100 LP100 = 1,MM
         BLAT(LP100) = 0.0
         GBUP(LP100) = 0.0
         GBLAT(LP100) = 0.0
  100 CONTINUE
      DO 120 LP120 = 1,2
         IF (IUP(K,LP120) .EQ. 0) GO TO 120
         JJ120 = IUP(K,LP120)
         QUP = QUP + Q(JJ120)
         DO 110 LP110 = 1,MM
            GBUP(LP110) = GBUP(LP110) + GBO(JJ120,LP110)
  110    CONTINUE
  120 CONTINUE
      DO 140 LP140 = 1,3
         IF (IWS(K,LP140) .EQ. 0) GO TO 140
         JJ140 = IWS(K,LP140)
         QUP = QUP + QWS(JJ140)
         DO 130 LP130 = 1,MM
            GBUP(LP130) = GBUP(LP130) + GBOWS(JJ140,LP130)
  130    CONTINUE
  140 CONTINUE
```

```
C
C     DETERMINE THE LATERAL INFLOW RATE.
C
      DO 160 LP160 = 1,2
         IF (IPL(K,LP160) .EQ. 0) GO TO 160
         JJ160 = IPL(K,LP160)
         QLAT = QLAT + QPL(JJ160)
         DO 150 LP150 = 1,MM
            GBLAT(LP150) = GBLAT(LP150) + GBOPL(JJ160,LP150) * SLEN(K)

            BLAT(LP150) = GBLAT(LP150) * DTS
  150    CONTINUE
  160 CONTINUE
C
C     DEFINE THE CONNECTION INFLOW.
C
      IF (ICON(K) .EQ. 0) GO TO 180
      READ (20,190) QCON
      QUP = QUP + QCON/0.02832
      READ (20,190) (GBCON(IMPD1),IMPD1 = 1,MM)
      DO 170 LP170 = 1,MM
         GBUP(LP170) = GBUP(LP170) + GBCON(LP170)/0.0929
  170 CONTINUE
  180 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  190 FORMAT (8F10.0)
      END
```

SUBROUTINE WROUT (K, J)

```
      SUBROUTINE WROUT (K,J)
      COMMON /ARAYS/        A(10,10)     , A1(10)       , A2(10)       ,
     1        ADF(10)      , AGB(10)      , B1(10)       , B2(10)       ,
     2        BEX(10)      , BLAT(10)     , BTEM(10)     , C(10)        ,
     3        DELTS(10)    , DMB(10,10)   , DNB(10,10)   , EGB(10)      ,
     4        GBC(10)      , GBO(10,10)   , GBOPL(20,10), GBOWS(10,10),
     5        GBUP(10)     , ICON(10)     , IPL(20,2)    , ISEG(10)     ,
     6        IUP(10,2)    , IWS(10,3)    , PB0(10,10)   , PB1(10,10)   ,
     7        PORB(10)     , PORDS(10)    , Q(100)       , QDUM(10)     ,
     8        QOUT(200)    , QP(10,10)    , QPL(20)      , QTOUT(10)    ,
     9        QTPL(20)     , QTWS(10)     , QWS(10)      , RB(10,5,10)  ,
     A        SB(10,5,10)  , SEDPL(20,10), SEDWS(10,10), SI(10)       ,
     B        SIN(10,5)    , SLEN(10)     , SLOP(10,5)   , SLOP1(10)    ,
     C        SUC(10)      , SW(10)       , T(10)        , TIME(200)    ,
     D        TSEDO(10,10), VISCO(10)    , WETK(10)     , XN(10)       ,
     E        ZBL(10)
      COMMON /BLOCK/        ALAT         , ALP          , AREA         ,
     1        ASUM         , BET          , BPER         , CPR          ,
     2        DT           , DTS          , DTX          , EPR          ,
     3        EPS          , IMAX         , MM           , NDX          ,
     4        NPL          , NSEG         , NUM          , NWS          ,
     5        QE           , QLAT         , QUP          , SSUM         ,
     6        YRSED
C
C     SET UP A-Q RELATIONSHIP.
C
      QAVE = 0.5 * (QUP + QP(K,J))
      BEM = BET - 1.0
      BEN = BEM - 1.0
      ALBET = ALP * BET
      ALBEM = ALP * BET * BEM
      DTXA = DTX + ALP
      ERROR = EPS * ASUM
```

D-114

```
C
C     LINEAR SCHEME TO FIND THE FIRST APPROXIMATION.
C
      ITER = 0
      IF (QAVE .LE. 1.0E - 5) GO TO 100
      DAQ = ALBET * QAVE *  * BEM
      QE = (ALAT + DTX * QUP + DAQ * QP(K,J))/(DTX + DAQ)
      GO TO 110
  100 QE = ASUM/DTXA
C
C     NONLINEAR SCHEME TO REFINE THE SOLUTION.
C
  110 ITER = ITER + 1
      AEST = DTX * QE + ALP * QE *  * BET
      ADEV = ASUM - AEST
      IF (ABS(ADEV) .LE. ERROR) GO TO 160
      IF (ITER .LT. IMAX) GO TO 120
      WRITE (99,170)
      CALL EXIT
  120 FDER = DTX + ALBET * QE *  * BEM
      SDER = ALBEM * QE *  * BEN
      BB = FDER/SDER
      SC = 2.0 * ADEV/SDER
      STEM = BB * BB + SC
      IF (STEM .GE. 0.0) GO TO 130
      QE = QE + ADEV/FDER
      GO TO 110
  130 STEM = SQRT (STEM)
      IF (ADEV .GT. 0.0) GO TO 150
      ETEM = BB + STEM
      QE = QE - ETEM
      IF (QE .GT. 0.0) GO TO 110
  140 ETEM = 0.5 * ETEM
      QE = QE + ETEM
      IF (QE .GT. 0.0) GO TO 110
      GO TO 140
  150 X1 = QE - BB - STEM
      X2 = QE - BB + STEM
      AD1 = ABS (ASUM - DTX * X1 - ALP * X1 *  * BET)
      AD2 = ABS (ASUM - DTX * X2 - ALP * X2 *  * BET)
      QE = X1
      IF (AD1 .GT. AD2) QE = X2
      GO TO 110
  160 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  170 FORMAT (20X,38HPROGRAM IS STOPPED AT STOP NUMBER TWO.)
      END
```

PROGRAM PRELOT

```
      PROGRAM PREPLOT
     1(INPUT,OUTPUT,TAPE1=513,TAPE2=513,TAPE3=513,TAPE4=513,TAPE6=OUTPUT
     2,TAPE7=65)
C     ******************************************************************
C     THIS PROGRAM ARRANGES THE HYDROGRAPHS DUE TO VARIOUS MANAGEMENT
C     ALTERNATIVES FOR THE STORM EVENTS WITH RUNOFF INTO ONE FILE.
C     ******************************************************************
C
C     ******************************************************************
C     INPUT AND OUTPUT DICTIONARY.
C     ******************************************************************
C
C     INPUT FILES
C        READ (1)       = AL1XXX
C        READ (2)       = AL2XXX
C        READ (3)       = AL3XXX
C        READ (4)       = AL4XXX
C
C     OUTPUT FILES
C        WRITE (6,FM)   = LINE PRINTER
C        WRITE (7,FM)   = ALSXXX
C
C     ******************************************************************
C
      DIMENSION              BT(4)        , DT(4)        , INUM(4)      ,
     1        ISTRM(366)   , IT(4)        , NEVT(4)      , NUMDA(4,366) ,
     2        Q(4,200)     , QO(200)      , T(4,200)     , TO(200)
C
C     INITIALIZE YEAR  COUNTER.
C
      NYEAR = 0
C
C     INCREMENT YEAR COUNTER.
C
   11 NYEAR = NYEAR + 1
C
C     OUTPUT YEAR NUMBER.
C
      WRITE (6,311) NYEAR
C     ******************************************************************
C     READ TAPES FOR SORTING INFORMATION AND BACKSPACE TO THE PREVIOUS
C     END-OF-FILE.
C     ******************************************************************
      DO 51 LP51 = 1,4
         II51 = LP51
C
C     JSTRT IS THE JULIAN DATE OF THE FIRST DAY OF THE SIMULATION AND
C     MUST BE THE SAME DAY FOR EVERY MANAGEMENT ALTERNATIVE.  NEVT
C     (LP51) IS THE NUMBER OF STORM EVENTS WITH RUNOFF FOR THE
C     ALTERNATIVE LP51.
C
         READ (II51) JSTRT,NEVT(LP51)
C
C     IF ALTERNATIVE LP51 WAS NOT RUN, THERE ARE NO STORM EVENTS (NEVT
C     (LP51) = 0) AND THERE WAS NO BEGINNING OF SIMULATION (JSTRT = 0).
C
         IF (EOF(II51) .NE. 0.0) NEVT(LP51) = - 1
         IF (NEVT(LP51) .EQ. - 1) JSTRT = 0
         NEV = NEVT(LP51)
         NR = 1
C
C     GIVE USER ALTERNATIVE DATA ABOUT EVENTS.
```

Reproduced from best available copy.

```
C
      WRITE (6,321) LP51,JSTRT,NEV
      IF (NEV .LT. 1) GO TO 31
      DO 21 LP21 = 1,NEV
C
C     NUMDA IS THE JULIAN DATE OF THE STORM EVENT WITH RUNOFF AND ITC
C     IS THE NUMBER OF POINTS IN THE ASSOCIATED HYDROGRAPH.  BTIME IS
C     THE TIME BETWEEN THE START OF DAY OF RAINFALL AND THE START OF
C     RUNOFF.  BTIME IS A DUMMY VARIABLE.
C
         READ (IT51) NUMDA(LP51,LP21),ITC,BTIME
         NR = NR + 1
C
C     CHANGE VALUES OF JULIAN DATES FOR SORTING PURPOSES.
C
         IF (NUMDA(LP51,LP21) .LT. JSTRT) NUMDA(LP51,LP21) = NUMDA(LP
     1   51,LP21) + 400
C
C     TO IS THE TIME ARRAY FOR THE HYDROGRAPH AND QO IS THE DISCHARGE
C     ARRAY FOR THE HYDROGRAPH.
C
         READ (IT51) (TO(IHPD1),QO(IHPD1),IHPD1 = 1,ITC)
         NR = NR + ITC
   21    CONTINUE
C
C     BACKSPACE TO PREVIOUS EOF.
C
   31    DO 41 LP41 = 1,NR
         BACKSPACE IT51
   41    CONTINUE
   51 CONTINUE
C     ******************************************************************
C     ESTABLISH THE TOTAL NUMBER OF INDIVIDUAL EVENTS AND THEIR JULIAN
C     DATES.
C     ******************************************************************
      NNN = 5
      NSTOS = 0
C
C     FIND THE LOWEST ORDINAL FOR AN ALTERNATIVE WHICH HAS EVENTS WITH
C     RUNOFF.
C
      DO 61 LP61 = 1,4
         IT61 = 5 - LP61
         IF (NEVT(IT61) .GT. 0) NNN = IT61
   61 CONTINUE
C
C     IF THERE ARE 4 EOF'S WITH RUNOFF THIS YEAR, INFORM USER AND
C     TERMINATE THE PROGRAM.
C
      NEOF = 0
      DO 71 LP71 = 1,4
         NEOF = NEOF + NEVT(LP71)
   71 CONTINUE
      IF (NNN .GE. 5) WRITE (6,331) NSTOS,NYEAR
      IF (NEOF .EQ. - 4) WRITE (6,341)
      IF (NEOF .EQ. - 4) GO TO 301
C
C     INITIALIZE LIST OF EVENTS WITH RUNOFF.
C
      NSTOS = NEVT(NNN)
      DO 81 LP81 = 1,NSTOS
         ISTRM(LP81) = NUMDA(NNN,LP81)
   81 CONTINUE
C
C     DETERMINE WHICH EVENTS WHICH NEED TO BE ADDED TO LIST.
C
      DO 111 LP111 = 1,4
         IF (LP111 .LE. NNN) GO TO 111
         IF (NEVT(LP111) .LT. 1) GO TO 111
         NEV = NEVT(LP111)
         DO 101 LP101 = 1,NEV
C
C     CHECK TO SEE IF EVENT IS ALREADY IN THE LIST.
```

```
C
          DO 91 LP91 = 1,NSTOS
             IF (NUMDA(LP111,LP101) .EQ. ISTRM(LP91)) GO TO 101
  91      CONTINUE
C
C     IF EVENT IS NOT IN THE LIST ADD TO THE LIST AND INCREMENT NUMBER
C     OF STORMS.
C
          NSTOS = NSTOS + 1
          ISTRM(NSTOS) = NUMDA(LP111,LP101)
  101   CONTINUE
  111 CONTINUE
C     ******************************************************************
C     ARRANGE THE EVENTS IN CHRONOLOGICAL ORDER.
C     ******************************************************************
      IF (NSTOS .LE. 1) GO TO 141
      NST1 = NSTOS - 1
      DO 131 LP131 = 1,NST1
C
C     FIND THE LP131ST EARLIEST EVENT WITH RUNOFF AND ITS LOCATION IN
C     THE LIST.
C
         INUM = LP131
         IMIN = ISTRM(LP131)
         II131 = LP131 + 1
         DO 121 LP121 = II131,NSTOS
            IF (ISTRM(LP121) .LT. IMIN) INUM = LP121
            IF (ISTRM(LP121) .LT. IMIN) IMIN = ISTRM(LP121)
  121    CONTINUE
         IF (INUM .EQ. LP131) GO TO 131
C
C     REARRANGE STORM ARRAY TO REFLECT FINDINGS.
C
         ISTRM(INUM) = ISTRM(LP131)
         ISTRM(LP131) = IMIN
  131 CONTINUE
C     ******************************************************************
C     RETURN JULIAN DATES TO THEIR ORIGINAL VALUES.
C     ******************************************************************
  141 DO 151 LP151 = 1,NSTOS
         IF (ISTRM(LP151) .GT. 400) ISTRM(LP151) = ISTRM(LP151) - 400
  151 CONTINUE
      DO 171 LP171 = 1,4
         NEV = NEVT(LP171)
         IF (NEV .LT. 1) GO TO 171
         DO 161 LP161 = 1,NEV
            IF (NUMDA(LP171,LP161) .GT. 400) NUMDA(LP171,LP161) = NUMDA(
     1      LP171,LP161) - 400
  161    CONTINUE
  171 CONTINUE
C
C     GIVE USER CHRONOLOGICAL LIST OF ALL EVENTS WITH RUNOFF.
C
      WRITE (6,351) NSTOS,(ISTRM(INPD2),INPD2 = 1,NSTOS)
C     ******************************************************************
C     POSITION FILES.
C     ******************************************************************
      DO 181 LP181 = 1,4
         II181 = LP181
C
C     JBEGN IS A DUMMY VARIABLE.
C
         READ (II181) JBEGN
  181 CONTINUE
C     ******************************************************************
C     WRITE ALL THE HYDROGRAPHS FOR THE SAME EVENT. EACH SUCH HYDROGRAPH
C     IS DUE TO A DIFFERENT MANAGEMENT ALTERNATIVE.
C     ******************************************************************
      KEND = 0
      DO 281 LP281 = 1,NSTOS
         ITJJ = 0
         ITJJN = 0
C
```

```
C     FIND THE ALTERNATIVE WHICH HAS THE LARGEST NUMBER OF POINTS IN
C     ITS HYDROGRAPH AND THE NUMBER OF POINTS IN ITS HYDROGRAPH.
C
        DO 231 LP231 = 1,4
           II231 = LP231
           NEV = NEVT(LP231)
           IF (NEV .LT. 1) GO TO 201
           DO 191 LP191 = 1,NEV
              IF (ISTRM(LP281) .EQ. NUMDA(LP231,LP191)) GO TO 211
 191       CONTINUE
C
C     IF THE ALTERNATIVE DID NOT RESULT IN A RUNOFF FOR THE STORM
C     EVENT, SET THE NUMBER OF POINTS IN THE HYDROGRAPH TO ZERO.
C     SET THE TIME BETWEEN START OF DAY OF RAINFALL AND START OF
C     RUNOFF TO A NEGATIVE ONE.
C
 201       IT(LP231) = 0
           BT(LP231) = - 1.0
           GO TO 221
C
C     IF THE ALTERNATIVE RESULTED IN RUNOFF FOR THE STORM EVENT, READ
C     THE NUMBER OF POINTS IN THE HYDROGRAPH FROM THE FILE.  NUMB IS A
C     DUMMY VARIABLE.
C
 211       READ (II231) NUMB,IT(LP231),BT(LP231)
           ITI = IT(LP231)
C
C     READ THE HYDROGRAPH FOR THE ALTERNATIVE.
C
           READ (II231) (T(LP231,IMPD3),Q(LP231,IMPD3),IMPD3 = 1,ITI)
C
C     CALCULATE THE TIME STEP IN THE TIME ARRAY OF THE HYDROGRAPH.
C
           DT(LP231) = T(LP231,2) - T(LP231,1)
C
C     CALCULATE THE ALTERNATIVE NUMBER (ITJJN) WHICH HAS THE LARGEST
C     HYDROGRAPH AND THE NUMBER OF POINTS (ITJJ) IN THE HYDROGRAPH.
C
 221       IF (ITJJ .LT. IT(LP231)) ITJJN = LP231
           IF (ITJJ .LT. IT(LP231)) ITJJ = IT(LP231)
 231    CONTINUE
C
C     EXTEND ALL HYDROGRAPHS FOR THE SAME EVENT (REGARDLESS OF THE
C     ALTERNATIVE) SO THAT ALL HAVE THE SAME NUMBER OF POINTS AS DOES
C     THE LARGEST.
C
        DO 251 LP251 = 1,4
           ITI = IT(LP251)
           IF (ITJJ .EQ. ITI) GO TO 251
           ITI1 = ITI + 1
           DO 241 LP241 = ITI1,ITJJ
C
C     IF THE ALTERNATIVE LP251 DID NOT RESULT IN RUNOFF, SET THE LP251ST
C     TIME ARRAY EQUAL TO THAT FOR THE LARGEST HYDROGRAPH.
C
              IF (ITI .LT. 1) T(LP251,LP241) = T(ITJJN,LP241)
C
C     IF THE ALTERNATIVE LP251 DID RESULT IN RUNOFF, EXTEND THE LP251ST
C     TIME ARRAY BY THE APPROPRIATE TIME INCREMENT.
C
              IF (ITI .GE. 1) T(LP251,LP241) = FLOAT (LP241 - ITI) * DT
     1        (LP251) + T(LP251,ITI)
C
C     ZERO FILL THE EXTENDED PORTION OF THE DISCHARGE ARRAY.
C
              Q(LP251,LP241) = 0.0
 241       CONTINUE
 251    CONTINUE
C
C     FIND THE MAXIMUM DISCHARGE VALUE OF THE STORM.
C
        QMAX = Q(1,1)
        DO 271 LP271 = 1,4
```

```
          DO 261 LP261 = 1,ITJJ
             IF (Q(LP271,LP261) .GT. QMAX) QMAX = Q(LP271,LP261)
  261       CONTINUE
  271    CONTINUE
C
C     COMPUTE THE BEGINNING AND ENDING OF THE ARRAYS FOR THIS STORM.
C
         KFRST = KEND + 1
         KEND = KEND + ITJJ
C
C     INFORM USER ABOUT THE STORM ORDINAL, ITS JULIAN DATE AND THE
C     LENGTH OF THE LARGEST HYDROGRAPH, AND THE MAXIMUM DISCHARGE OF
C     THE STORM UNDER ANY ALTERNATIVE, AND WHERE THE ARRAYS FOR THE
C     STORM ARE LOCATED ON THE FILE, AND THE FINAL AND BEGINNING TIMES
C     FOR EACH ALTERNATIVE.
C
         WRITE (6,361) LP281,ISTRM(LP281),ITJJ,QMAX,KFRST,KEND,(T(IMPD4,
     1   ITJJ),IMPD4 = 1,4),(BT(IMPD5),IMPD5 = 1,4)
C
C     OUTPUT ALL THE ALTERNATIVE HYDROGRAPHS FOR THE STORM EVENT.
C
         WRITE (7,371) ((T(IMPD6,IMPD7),Q(IMPD6,IMPD7),IMPD6 = 1,4),IMPD
     1   7 = 1,ITJJ)
  281 CONTINUE
      DO 291 LP291 = 1,4
         II291 = LP291
         IF (NEVT(LP291) .EQ. - 1) BACKSPACE II291
         IF (NEVT(LP291) .LE. 0) GO TO 291
         READ (II291) IDUM(LP291)
         IF (EOF(II291) .NE. 0.0) GO TO 291
  291 CONTINUE
      GO TO 11
C
C     TERMINATE PROGRAM NORMALLY.
C
  301 CONTINUE
      STOP
C
C     VARIOUS FORMATS.
C
  311 FORMAT (/20X,22HTHE SIMULATION YEAR IS,6X,I2/)
  321 FORMAT (/20X,22HMANAGEMENT ALTERNATIVE,7X,I1/20X,23HFIRST DAY OF S
     1IMULATION,4X,I3/20X,23HNUMBER OF RUNOFF EVENTS,4X,I3/)
  331 FORMAT (/20X,23HTHE NUMBER OF STORMS IS,2X,I2,2X,18HIN SIMULATION
     1YEAR,1X,I2/)
  341 FORMAT (/20X,22HTHE END OF SIMULATION./)
  351 FORMAT (/20X,29HTOTAL NUMBER OF RUNOFF EVENTS,3X,I3//20X,12HJULIAN
     1 DATES,/(20X,I10))
  361 FORMAT (/20X,13HSTORM NUMBER=,I4,1X,12HJULIAN DATE=,I4,1X,21HNUMBE
     1R OF ITERATIONS=,I10/20X,31HMAXIMUM DISCHARGE OF THE STORM=,E20.10
     2,/20X,32HTHE ARRAYS BEGIN ON LINE NUMBER ,I5,24H AND END ON LINE N
     3UMBER ,I5/20X,19HTHE FINAL TIMES ARE,4(2X,F10.2)/,20X,70HTHE TIMES
     4 BETWEEN THE START OF DAY OF RAINFALL AND START OF RUNOFF ARE,/20X
     5,56H(IN MINUTES WITH -1.0 INDICATING NO RUNOFF HAS OCCURRED),/,20X
     6,4(2X,F10.2)//)
  371 FORMAT (4(F10.2,F10.4))
      END
```

Reproduced from best available copy.

D-115

PROGRAM ALTPLOT

```
      PROGRAM ALTPLOT
     1(INPUT,OUTPUT,TAPE81=513,TAPE82=513,TAPE83=513,TAPE84=513,TAPE90=5
     213,TAPE91=513,TAPE92=513,TAPE93=OUTPUT)
C     ################################################################
C     THIS PROGRAM COMBINES THE INFORMATION ON SEVERAL FILES WHICH WILL
C     BE NEEDED IN ORDER TO PLOT THE RESULTS OF THE PRESENT MANAGEMENT
C     ALTERNATIVE.  AHYXXX IS WRITTEN BY HYDRL.  AMUXXX IS WRITTEN BY
C     MULTW.  AMCXXX IS WRITTEN BY MCHNL.
C     ################################################################
C
C     ################################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ################################################################
C
C     INPUT FILES
C        READ (90)     = AL0XXX = AHYXXX
C        READ (91)     = AMUXXX
C        READ (92)     = AMCXXX
C
C     OUTPUT FILES
C        WRITE (81)    = AL1XXX
C        WRITE (82)    = AL2XXX
C        WRITE (83)    = AL3XXX
C        WRITE (84)    = AL4XXX
C        WRITE (93,FM) = LINE PRINTER
C
C     ################################################################
      DIMENSION          QOUT(200)   , TIME(200)
C
C     REWIND INPUT FILES.
C
      DO 11 LP11 = 90,92
         REWIND LP11
   11 CONTINUE
C
C     INPUT THE ALTERNATIVE NUMBER (NALT) AND THE FIRST DAY OF SIMULA-
C     TION (JSTRT).
C
      READ (90) NALT,JSTRT
C
C     IF THE ALTERNATIVE NUMBER IS IN ERROR, INFORM THE USER AND END
C     THE PROGRAM.
C
      IF ((0 .GE. NALT) .OR. (5 .LE. NALT)) WRITE (93,51) NALT
      IF ((0 .GE. NALT) .OR. (5 .LE. NALT)) CALL EXIT
C
C     COMPUTE THE TAPE NUMBER WHICH CORRESPONDS TO THE ALTERNATIVE.
C
      NTAPE = 80 + NALT
C
C     INPUT THE NUMBER OF STORM EVENTS WITH THRESHOLD RUNOFF (NEVT)
C     UNDER THIS ALTERNATIVE.
C
      READ (92) NEVT
      WRITE (NTAPE) JSTRT,NEVT
      IF (NEVT .LT. 1) GO TO 41
C
C     IF THERE STORMS WITH RUNOFF ARRANGE THE DATA AND OUTPUT.
C
      DO 31 LP31 = 1,NEVT
         READ (91) J1,NUMDA
         READ (91) BTIME
         READ (92) J2
         READ (92) ITC,(TIME(IMPD1),QOUT(IMPD1),IMPD1 = 1,ITC)
C
C     READJUST TIME ARRAY SO THAT TIMES ARE RELATIVE TO THE BEGINNING
C     OF RAINFALL.
C
```

D-116

```
      DO 21 LP21 = 1,ITC
         TIME(LP21) = TIME(LP21) + BTIME
21    CONTINUE
C
C     CHECK THAT THE FILES AMUXXX AND AMCXXX ARE READING THE SAME EVENT.
C     EVENT.  IF NOT, INFORM THE USER.
C
      IF ((LP31 .NE. J1) .OR. (LP31 .NE. J2)) WRITE (93,61) LP31,J1,J
     1 2
C
C     FOR EACH STORM EVENT, WRITE TO THE FILE THE JULIAN DATE (NUMDA),
C     THE NUMBER OF POINTS IN THE HYDROGRAPH (ITC), THE BEGINNING TIME
C     OF RUNOFF (BTIME), AND THE HYDROGRAPH (TIME,QOUT).
C
      WRITE (NTAPE) NUMDA,ITC,BTIME
      WRITE (NTAPE) (TIME(IMPD2),QOUT(IMPD2),IMPD2 = 1,ITC)
31 CONTINUE
C
C     OUTPUT END-OF-SUBFILE MARK FOR ALTERNATIVE FILE.
C
      END FILE NTAPE
C
C     TERMINATE THE PROGRAM NORMALLY.
C
41 CONTINUE
   STOP
C
C     VARIOUS FORMATS.
C
51 FORMAT (20X,73HTHE ALTERNATIVE NUMBER IS IN ERROR.  IT MUST BE EIT
  1HER 1,2,3,OR 4.  IT IS,I10)
61 FORMAT (20X,49HTHE INDICIES ON THE FILES DO NOT MATCH.  THEY ARE,/
  120X,9HDO INDEX=,I5,1X,13HAMUXXX INDEX=,I5,1X,13HAMCXXX INDEX=,I5)
   END
```

D-117

PROGRAM NUTRINT

```
      BLOCK DATA
C
C     DECLARATION OF COMMON BLOCKS IN THE PROGRAM NUTRN.
C
      COMMON /ARAYS/        RA(721)     , IA(24)
      COMMON /BLOCK/        RB(71)      , IB(8)
      COMMON /BLOK2/        RC(3)
      END
      PROGRAM NUTRINT
     1(INPUT,OUTPUT,TAPE1=513,TAPE2=513,TAPE3=513,TAPE4=65,TAPE5=65,TAPE
     26=513,TAPE8=65,TAPE51=65,TAPE52=65,TAPE53=65,TAPE96=INPUT,TAPE97=O
     3UTPUT)
C
C     THIS IS THE NUTRIENT MODEL. THE NITROGEN AND PHOSPHORUS CYCLES ARE
C     SIMULATED.
C
C     ******************************************************************
C     INPUT AND OUTPUT DICTIONARY.
C     ******************************************************************
C
C     INPUT FILES
C        READ (1)       = VOLXXX
C        READ (2)       = SEDXXX
C        READ (3)       = THNXXX
C        READ (4,FM)    = MOIXXX
C        READ (5,FM)    = CONXXX
C        READ (6)       = NGEXXX
C        READ (51,FM)   = MANXXX
C        READ (52,FM)   = T52XXX
C        READ (96,FM)   = NUIXXX
C
C     OUTPUT FILES
C        WRITE (97,FM)  = LINE PRINTER
C        WRITE (8,FM)   = NUTXXX
C        WRITE (53,FM)  = T53XXX
C
C     ******************************************************************
C
C
C     CHECK POSITIONING OF FILE MANXXX.
C
      NEOF = 1
      READ (51,11) IDUM
      IF (EOF(51) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (97,21)
      IF (NEOF .EQ. 0) CALL EXIT
C
C     CHECK POSITIONING OF FILE T52XXX.
C
      READ (52,11) IDUM
      IF (EOF(52) .EQ. 0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (97,31)
      IF (NEOF .EQ. 0) CALL EXIT
C
C     INPUT THE INITIAL CONDITIONS FOR THE MODEL.
C
      CALL DATA1
C
C     SIMULATE THE CYCLES.
C
      CALL ROUTE
C
C     TERMINATE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
```

D-112

```
11 FORMAT (A2)
21 FORMAT (/20X,51HFILE STRUCTURE ERROR ON TAPE51, MESSAGE FROM NUTRN
  1.,/)
31 FORMAT (/20X,53HFILE STRUCTURE ERROR ON TAPE52, MESSAGE FROM NUTRI
  1NT.,/)
   END
```

SUBROUTINE DATA1

```
      SUBROUTINE DATA1
C
C     THIS PROGRAM UNIT INITIALIZES, INPUTS, OR CALCULATES VARIABLES
C     THAT ARE GENERAL IN NATURE.
C
      COMMON /ARAYS/        FDNEW(50)   , FDOLD(50)   , HOS(2,50)   ,
     1        NDACH(24)   , SCON(10)    , SGBB(10)    , SIZE(10)    ,
     2        SKP(3,10)   , SKPP(3,10)  , SSEM(10)    , SSEW(10)    ,
     3        TEMP(366)   , TITLE(20)   , XS(14)      , XT(11)
      COMMON /BLOCK/        A           , AI          , AL          ,
     1        B           , DO          , DECAY       , DENOM       ,
     2        DL          , DS          , DSL         , DT          ,
     3        E1          , E2          , E3          , E4          ,
     4        E5          , E6          , F1          , F2          ,
     5        FR          , FRA         , FRR         , GG          ,
     6        H           , IND         , INK         , ITCOM       ,
     7        JCHAN       , MM          , NDX         , NOPL        ,
     8        NUMCH       , PPTA        , PPTN        , PPTP        ,
     9        QES         , RILA        , RILN        , RISA        ,
     A        RISN        , RITM1       , RJAS        , RJSA        ,
     B        RKAS        , RKP         , RKPS        , RKPST       ,
     C        RKSA        , RKSP        , RKSPT       , RLAL        ,
     D        RLAN        , RLIT        , RLITR       , RLNA        ,
     E        RLNH        , RLNL        , RLNO        , RLOM        ,
     F        RLOMT       , RLOP        , RLP         , RLPL        ,
     G        ROM         , ROR         , RPA         , RSAN        ,
     H        RSN         , RSNA        , RSNH        , RSNO        ,
     I        RSP         , RSPL        , SGL         , SGS         ,
     J        SLEN        , SQ          , SSED        , SUMX
C
C     DL = THICKNESS OF THE UPPER ZONE OF LITTER LAYER (METERS).
C
      DL = 0.02
C
C     TIME INCREMENT (MINUTES).
C
      DT = 120.0
C
C     CONVERT DT TO FRACTION OF A DAY.
C
      DT = DT/1440.0
C
C     GENERAL INPUT.
C
      READ (96,100) TITLE
      WRITE (97,110) TITLE
      READ (96,120) NDX
      READ (96,130) E1,E2,E3,E4,E5,E6,RPA,RKP
      READ (96,130) RLAN,RLNA,RSAN,RSNA,RKAS,RKSA,RKPS,RKSP
      READ (96,130) RLOM
      READ (96,120) INK
      READ (96,140) ((SKP(I,J),J=1,10),I=1,3)
      READ (96,140) ((SKPP(I,J),J=1,10),I=1,3)
C
C     CALCULATE NUMBER OF PLANES IN SIMULATION (NOPL).
C
```

D-119

```
      READ (5,120) NPL,NWS
      NOPL = 2 * NWS + NPL
      RETURN
C
C     VARIOUS FORMATS.
C
  100 FORMAT (20A4)
  110 FORMAT (/20X,20A4,//)
  120 FORMAT (2I10)
  130 FORMAT (8F10.5)
  140 FORMAT(10F8.1)
      END
```

SUBROUTINE DATA2

```
      SUBROUTINE DATA2
C
C     THIS PROGRAM UNIT INITIALIZES, INPUTS, OR CALCULATES VARIABLES
C     THAT ARE DEPENDENT SOLELY UPON THE PLANE IN QUESTION.
C
      COMMON /ARAYS/        FDNEW(50)    , FDOLD(50)    , HQS(2,50)    ,
     1       NDACH(24)    , SCON(10)     , SGBB(10)     , SIZE(10)     ,
     2       SKP(3,10)    , SKPP(3,10)   , SSEM(10)     , SSEW(10)     ,
     3       TEMP(366)    , TITLE(20)    , XS(14)       , XT(11)
      COMMON /BLOCK/        A            , AI           , AL           ,
     1       B            , DO           , DECAY        , DENOM        ,
     2       DL           , DS           , DSL          , DT           ,
     3       E1           , E2           , E3           , E4           ,
     4       E5           , E6           , F1           , F2           ,
     5       FR           , FRA          , FRR          , GG           ,
     6       H            , IND          , INK          , ITCOM        ,
     7       JCHAN        , MM           , NDX          , NOPL         ,
     8       NUMCH        , PPTA         , PPTN         , PPTP         ,
     9       QES          , RILA         , RILN         , RISA         ,
     A       RISN         , RITM1        , RJAS         , RJSA         ,
     B       RKAS         , RKP          , RKPS         , RKPST        ,
     C       RKSA         , RKSP         , RKSPT        , RLAL         ,
     D       RLAN         , RLIT         , RLITR        , RLNA         ,
     E       RLNH         , RLNL         , RLNO         , RLOM         ,
     F       RLOMT        , RLOP         , RLP          , RLPL         ,
     G       ROM          , ROR          , RPA          , RSAN         ,
     H       RSN          , RSNA         , RSNH         , RSNO         ,
     I       RSP          , RSPL         , SGL          , SGS          ,
     J       SLEN         , SQ           , SSED         , SUMX
      COMMON /BLOK2/        SWCFR        , THETA        , XPGP
C
C     INITIALIZE VARIABLES FOR NITROGEN AND PHOSPHORUS CYCLES ON THE
C     PLANE.
C
      H = 0.01
      GG = 0.01
      AI = 0.0
C
C     INITIALIZE VARIABLES FOR SUBSURFACE FLOW ON THE PLANE.
C
      DO 110 LP110 = 1,NDX
         DO 100 LP100 = 1,2
            HQS(LP100,LP110) = 0.0
  100    CONTINUE
         FDOLD(LP110) = 0.0
  110 CONTINUE
C
C     IND = PARAMETER USED TO INDICATE WHETHER THE LITTER LAYER IS
C     CONSIDERED IN THE MODEL SIMULATION OR NOT.
C      IND = 0  ....   NO LITTER LAYER CONSIDERED.
C      IND = 1  ....   LITTER LAYER HAS BEEN CONSIDERED.
```

D-120

```
C
      READ (96,140) IND
C
C     XS(1) = CONCENTRATION OF ORGANIC NITROGEN IN UPPER LITTER OR
C             SOIL ZONE IN THE WATERSHED (KILOGRAMS PER CUBIC METER).
C     XS(2) = CONCENTRATION OF AMMONIUM IN UPPER LITTER OR SOIL ZONE IN
C             THE WATERHSED.
C     XS(3) = CONCENTRATION OF NITRATE IN UPPER LITTER OR SOIL ZONE IN
C             THE WATERSHED.
C     XS(4) = CONCENTRATION OF ORGANIC NITROGEN IN LOWER LITTER OR SOIL
C             ZONE IN THE WATERSHED.
C     XS(5) = CONCENTRATION OF AMMONIUM IN LOWER LITTER OR SOIL ZONE IN
C             THE WATERSHED.
C     XS(6) = CONCENTRATION OF NITRATE IN LOWER LITTER OR SOIL ZONE IN
C             THE WATERSHED.
C     XS(7) = CONCENTRATION OF NITROGEN CONTAINED IN PLANTS OF WATERSHED
C             IN KILOGRAMS PER SQUARE METER.
C     XS(8) = CONCENTRATION OF SOLUBLE AMMONIUM IN SOIL OF WATERSHED
C             IN KILOGRAMS PER CUBIC METER.
C     XS(9) = CONCENTRATION OF NITRATE IN SOIL (KILOGRAMS PER CUBIC
C             METER).
C     XS(10) = CONCENTRATION OF ADSORBED AMMONIUM IN SOIL (KILOGRAMS
C              PER CUBIC METER).
C     XS(11) = TOTAL NITROGEN LOADING THROUGH RUNOFF AND SUBSURFACE FLOW
C              (KILOGRAMS).
C     XS(12) = NITRATE LOADING THROUGH RUNOFF WATER (KILOGRAMS).
C     XS(13) = AMMONIUM LOADING THROUGH RUNOFF WATER (KILOGRAMS).
C     XS(14) = INORGANIC NITROGEN LOADING TO GROUNDWATER (KILOGRAMS).
C
      READ (52,150) (XS(IMPD1),IMPD1 = 1,14)
C
C     XT(1) = CONCENTRATION OF ORGANIC PHOSPHORUS IN UPPER LITTER OR
C             SOIL ZONE (KILOGRAMS PER CUBIC METER).
C     XT(2) = CONCENTRATION OF INORGANIC PHOSPHORUS IN UPPER LITTER OR
C             SOIL ZONE (KILOGRAMS PER CUBIC METER).
C     XT(3) = CONCENTRATION OF ORGANIC PHOSPHORUS IN LOWER LITTER OR
C             SOIL ZONE (KILOGRAMS PER CUBIC METER).
C     XT(4) = CONCENTRATION OF INORGANIC PHOSPHORUS IN LOWER LITTER OR
C             SOIL ZONE (KILOGRAMS PER CUBIC METER).
C     XT(5) = CONCENTRATION OF PHOSPHORUS CONTAINED IN PLANTS OF THIS
C             WATERSHED (KILOGRAMS PER SQUARE METER).
C     XT(6) = CONCENTRATION OF INORGANIC PHOSPHORUS DISSOLVED IN SOIL
C             WATER (KILOGRAMS PER CUBIC METER).
C     XT(7) = CONCENTRATION OF INORGANIC PHOSPHORUS ADSORBED TO SOIL
C             PARTICLES (KILOGRAMS PER CUBIC METER).
C     XT(8) = TOTAL PHOSPHORUS LOADING THROUGH RUNOFF AND SUBSURFACE
C             FLOW (KILOGRAMS).
C     XT(9) = PHOSPHORUS LOADING THROUGH SEDIMENT (KILOGRAMS).
C     XT(10) = ORTHOPHOSPHATE LOADING THROUGH RUNOFF WATER (KILOGRAMS).
C     XT(11) = ORTHOPHOSPHATE LOADING TO GROUNDWATER (KILOGRAMS).
C
      READ (52,150) (XT(IMPD2),IMPD2 = 1,11)
      READ (52,150) DO
      READ (96,150) RLP,RLPL,RSPL,ROR,RSP
C
C     P = ANNUAL PRECIPITATION OF THE WATERSHED (MILLIMETERS PER YEAR).
C
      READ (96,150) P,ROM,RSN
C
C     RLIT = INPUT OF LITTER TO LITTER LAYER (KILOGRAMS PER HECTARE
C            PER YEAR).
C
      READ (51,150) RLIT
      READ (96,150) RSNH,RSNO
C
C     DS = THICKNESS OF THE SOIL LAYER (METERS).
C     DSL = THICKNESS OF THE LOWER ZONE OF LITTER LAYER (METERS).
C     RH = AVERAGE RELATIVE HUMIDITY OF THE AIR (PERCENT).
C     SGL = SPECIFIC GRAVITY OF LITTER.
C     SGS = SPECIFIC GRAVITY OF SOIL.
C
      READ (96,150) DS,DSL,RH,SGL,SGS
C
C     CONVERT UNITS.
C
```

```
      SGS = SGS * 1000.0
      SGL = SGL * 1000.0
C
C     PPTN = NITRATE INPUT TO THE WATERSHED BY PRECIPITATION (KILOGRAMS
C            PER SQUARE METER PER DAY).
C     PPTA = AMMONIUM INPUT TO THE WATERSHED BY PRECIPITATION (KILOGRAMS
C            PER SQUARE METER PER DAY).
C     PPTP = INORGANIC PHOSPHORUS INPUT TO THE WATERSHED BY
C            PRECIPITATION (KILOGRAMS PER SQUARE METER PER DAY).
C
      READ (96,160) PPTN,PPTA,PPTP,DECAY,F1,F2,FR
      READ (96,160) PERMX
C
C     INPUT NUMBER AND DATES OF NUTRIENT CHANGES BY MANAGEMENT.
C
      JCHAN = 1
      READ (51,140) NUMCH
      WRITE (97,170) NUMCH
      IF (NUMCH .LE. 0) GO TO 120
      READ (51,140) (NDACH(IMPD3),IMPD3 = 1,NUMCH)
      WRITE (97,180) (NDACH(IMPD4),IMPD4 = 1,NUMCH)
C
C     INPUT GEOMETRY DATA.
C
  120 READ (6) SLEN,WIDTH,SLOP1,PHI,SW,SFC,RIO
      ITCOM = IFIX (RIO)
      SGS = (1.0 - PHI) * SGS
C
C     COMPUTE AREA IN SQUARE METERS.
C
      A = SLEN * WIDTH
C
C     CALCULATE PARAMETERS FOR SUBSURFACE FLOW PROGRAM UNIT.
C
      AL = (PERMX * SLOP1 * 980.0)/(PHI * (SW - SFC) * 1.1E - 2)
      THETA = 864.0 * FLOAT (NDX)/SLEN
      DENOM = AL * THETA + 1.0
C
C     INPUT YEARLY TEMPERATURES AND FIND AVERAGE TEMPERATURE FOR
C     SIMULATION PERIOD.
C
      READ (3) (TEMP(IMPD5),IMPD5 = 1,ITCOM)
      TEMPA = 0.0
      DO 130 LP130 = 1,ITCOM
         TEMPA = TEMPA + TEMP(LP130)
  130 CONTINUE
      TEMPA = TEMPA/FLOAT (ITCOM)
C
C     CALCULATE PARAMETERS FOR NUTRIENT CYCLES.
C
      SVP = 10.0 *  * (9.2992 - 2360.0/(273.0 + TEMPA))
      GP = P/((1.0 - RH/100.0) * SVP)
      XPGP = EXP ( - 0.005 * GP)
      RETURN
C
C     VARIOUS FORMATS.
C
  140 FORMAT (8I10)
  150 FORMAT (8F10.5)
  160 FORMAT (3E10.3,4F10.4)
  170 FORMAT (/20X,43HNUMBER OF NUTRIENT CHANGES BY MANAGEMENT = ,I10/)
  180 FORMAT (20X,37HSIMULATION DATES OF NUTRIENT CHANGES./(20X,8I10))
      END
```

SUBROUTINE DATA3 (IT)

```
      SUBROUTINE DATA3 (IT)
C
C     THIS PROGRAM UNIT INITAILIZES, INPUTS, OR CALCULATES VARIABLES
C     THAT ARE DEPENDENT UPON THE PLANE AND THE DAY OF THE SIMULATION.
C
      COMMON /ARAYS/        FDNEW(50)   , FDOLD(50)   , HQS(2,50)   ,
     1        NDACH(24)   , SCON(10)    , SGBB(10)    , SIZE(10)    ,
     2        SKP(3,10)   , SKPP(3,10)  , SSEM(10)    , SSEW(10)    ,
     3        TEMP(366)   , TITLE(20)   , XS(14)      , XT(11)
      COMMON /BLOCK/        A           , AI          , AL          ,
     1        B           , DO          , DECAY       , DENOM       ,
     2        DL          , DS          , DSL         , DT          ,
     3        E1          , E2          , E3          , E4          ,
     4        E5          , E6          , F1          , F2          ,
     5        FR          , FRA         , FRR         , GG          ,
     6        H           , IND         , INK         , ITCOM       ,
     7        JCHAN       , NH          , NDX         , NOPL        ,
     8        NUMCH       , PPTA        , PPTN        , PPTP        ,
     9        QES         , RILA        , RILN        , RISA        ,
     A        RISN        , RITM1       , RJAS        , RJSA        ,
     B        RKAS        , RKP         , RKPS        , RKPST       ,
     C        RKSA        , RKSP        , RKSPT       , RLAL        ,
     D        RLAN        , RLIT        , RLITR       , RLNA        ,
     E        RLNH        , RLNL        , RLNO        , RLOM        ,
     F        RLOMT       , RLOP        , RLP         , RLPL        ,
     G        ROM         , ROR         , RPA         , RSAN        ,
     H        RSN         , RSNA        , RSNH        , RSNO        ,
     I        RSP         , RSPL        , SGL         , SGS         ,
     J        SLEN        , SQ          , SSED        , SUMX
      COMMON /BLOK2/        SWCFR       , THETA       , XPGP
C
C     CHECK THAT THERE ARE MANAGEMENT NUTRIENT CHANGES LEFT AND THEY
C     HAPPEN ON THE CURRENT SIMULATION DAY.
C
      IF (JCHAN .GT. NUMCH) GO TO 100
      IF (IT .NE. NDACH(JCHAN)) GO TO 100
C
C     INPUT CHANGES IN THE NUTRIENTS DUE TO MANAGEMENT PRACTICES.
C
      JCHAN = JCHAN + 1
      READ (51,130) (XS(IMPD1),IMPD1 = 1,6),(XS(IMPD2),IMPD2 = 8,10)
      READ (51,130) (XT(IMPD3),IMPD3 = 1,4),(XT(IMPD4),IMPD4 = 6,7)
C
C     INPUT THE RUNOFF DEPTH (QOUT) IN CENTIMETERS PER DAY AND THE
C     INFILTRATION RATE (FRA) IN CENTIMETERS PER DAY.
C
  100 READ (1) NB,QOUT,FRA
C
C     SQ = DISCHARGE OF SURFACE RUNOFF (CUBIC METERS PER DAY).
C
      SQ = QOUT * A /100.0
C
C     FRR = LEACHING RATE (METERS PER DAY).
C
      FRR = FRA/100.0
C
C     CALCULATE DEPENDENT VARIABLES.
C
      QQ = QOUT/100.0
      RLNO = 9.557E - 3 * QQ *  * (0.6195)
      RLNH = 1.232E - 4 + QQ * 5.11E - 3
      RLNL = 6.721E - 4 * QQ *  * (0.724)
      RLAL = 8.661E - 8 * QQ *  * (0.982)
C
C     TEMPL = AVERAGE TEMPERATURE OF LITTER (DEGREES CELSIUS).
C
      TEMPL = TEMP(IT) - 2.0
C
C     TEMPS = AVERAGE TEMPERATURE OF SOIL (DEGREES CELSIUS).
C
      TEMPS = TEMP(IT) - 3.0
```

```
C
C     CALCULATE PARAMETERS FOR NITROGEN CYCLE.
C
      RRL = 1.987E - 3 * (273.0 + TEMPL)
      RRS = 1.987E - 3 * (273.0 + TEMPS)
      RLOP = 10.0 *  * (7.71 - 2758.0/(273.0 + TEMPL))/7.0
      RILN = EXP ( - E1/RRL) * XPGP
      RILA = EXP ( - E2/RRL) * XPGP
      RISN = EXP ( - E1/RRS) * XPGP
      RISA = EXP ( - E2/RRS) * XPGP
      RJAS = EXP ( - E3/RRS)
      RJSA = EXP ( - E4/RRS)
C
C     CALCULATE PARAMETERS FOR PHOSPHORUS CYCLE.
C
      RLOMT = EXP ( - E1/RRL)
      RKPST = EXP ( - E5/RRS)
      RKSPT = EXP ( - E6/RRS)
C
C     SEDIMENT YIELD MUST BE INPUT FROM SMALLER PARTICLE SIZE TO LARGER
C     ONE.
C
      IF (NB .EQ. 1) READ (2) IDUM1,IDUM2,MM,(SGBB(IMPD5),IMPD5 = 1,MM),
     1(SIZE(IMPD6),IMPD6 = 1,MM)
      IF (NB .NE. 1) MM = 10
      SUMX = 0.0
      DO 110 LP110 = 1,MM
         IF (NB .NE. 1) SGBB(LP110) = 0.0
         IF (NB .NE. 1) SIZE(LP110) = 0.0
         SUMX = SUMX + SGBB(LP110)/SGS
  110 CONTINUE
C
C     SEDIMENT MIXTURE VOLUME AND SEDIMENT CONCENTRATION.
C
      SUMX = SUMX + SG
      DO 120 LP120 = 1,MM
         SCON(LP120) = 0.0
         IF (SUMX .NE. 0.0) SCON(LP120) = SGBB(LP120)/SUMX
C
C     COMPUTE THE MASSES OF SEDIMENT AND WATER IN THE MIXTURE.
C
         SSEW(LP120) = SUMX * 1000.0 * SGS/(SCON(LP120) + SGS)
         SSEM(LP120) = SUMX * SCON(LP120) * SGS/(SCON(LP120) + SGS)
  120 CONTINUE
C
C     SWC = SOIL WATER CONTENT (GRAMS OF WATER PER GRAM OF SOIL).
C
      READ (4,130) SWC
      SWCFR = 1.0 + SWC * 0.214
      RETURN
C
C     VARIOUS FORMATS.
C
  130 FORMAT (8F10.5)
      END
```

SUBROUTINE INPN (XP)

```
      SUBROUTINE INPN (XP)
C
C     THIS PROGRAM UNIT CALCULATES THE CHANGES IN THE NITROGEN CYCLE.
C
      COMMON /ARAYS/        FDNEW(50)    , FDOLD(50)    , HQS(2,50)    ,
     1       NDACH(24)    , SCON(10)     , SGBB(10)     , SIZE(10)     ,
     2       SKP(3,10)    , SKPP(3,10)   , SSEM(10)     , SSEW(10)     ,
     3       TEMP(366)    , TITLE(20)    , XS(14)       , XT(11)
      COMMON /BLOCK/        A            , AI           , AL           ,
     1       B            , DO           , DECAY        , DENOM        ,
     2       DL           , DS           , DSL          , DT           ,
     3       E1           , E2           , E3           , E4           ,
     4       E5           , E6           , F1           , F2           ,
     5       FR           , FRA          , FRR          , GG           ,
```

D-124

```
      6        H          , IND        , INK        , ITCOM      ,
      7        JCHAN      , MM         , NDX        , NOPL       ,
      8        NUMCH      , PPTA       , PPTN       , PPTP       ,
      9        QES        , RILA       , RILN       , RISA       ,
      A        RISN       , RITM1      , RJAS       , RJSA       ,
      B        RKAS       , RKP        , RKPS       , RKPST      ,
      C        RKSA       , RKSP       , RKSPT      , RLAL       ,
      D        RLAN       , RLIT       , RLITR      , RLNA       ,
      E        RLNH       , RLNL       , RLNO       , RLOM       ,
      F        RLOMT      , RLOP       , RLP        , RLPL       ,
      G        ROM        , ROR        , RPA        , RSAN       ,
      H        RSN        , RSNA       , RSNH       , RSNO       ,
      I        RSP        , RSPL       , SGL        , SGS        ,
      J        SLEN       , SQ         , SSED       , SUMX
      COMMON /BLOK2/        SWCFR      , THETA      , XPGP
      DIMENSION             XP(14)
C
C     SYSTEM EQUATIONS USED IN THE NITROGEN CYCLE MODELING FOR THE
C     STUDIED WATERSHED WERE AS FOLLOW.
C
      IF (IND .EQ. 0) GO TO 100
      XP(1) = (RLITR * F1 * (DT * RITM1 * (1.0 - EXP ( - DT * RITM1 * DE
     1CAY)) + DT * (1.0 - EXP ( - DT * DECAY)))/(DL * 3650000.0)) - (RLO
     2P * XS(1) * SWCFR) - (ROM * SSED * FR * XS(1)/(A * DL * SGL))
C
      XP(4) = (RLITR * F1 * (DT * RITM1 * (1.0 - EXP ( - DT * RITM1 * DE
     1CAY)) + DT * (1.0 - EXP ( - DT * DECAY)))/(DSL * 3650000.0)) - (RL
     2OP * XS(4) * SWCFR) - (ROM * SSED * FR * XS(4)/(A * DSL * SGL))
C
      ANI1 = RLAN * RILA * XS(2)
      XP(2) = (RLOP * XS(1) * SWCFR) -  ANI1         + (RLNA * RILN * XS
     1(3)) + (PPTA/DL) - (RLNH * XS(2) * SQ/(A * DL)) - (RLAL * XS(2) *
     2FRR/DL)
C
      XP(3) =    ANI1        - (RLNA * RILN * XS(3)) + (PPTN/DL) - (RLNO
     1* XS(3) * SQ/(A * DL)) - (RLNL * XS(3) * FRR/DL)
C
      ANI2 = RLAN * RILA * XS(5)
      XP(6) =    ANI2        - (RLNA * RILN * XS(6)) + (PPTN/DSL) - (RLNL
     1 * XS(6) * FRR/DSL) + (RLNL * XS(3) * FRR/DSL) - (RLNL * XS(6) * Q
     2ES/(A * DSL))
C
      ANI3 = RSAN * RISA * XS(8)
      XP(8) = (RSNA * RISN * XS(9)) -    ANI3        - (RPA * XS(8)) - (R
     1KAS * RJAS * XS(8)) + (RLAL * XS(5) * FRR/DS) - (RSNH * XS(8) * FR
     2R/DS) + (RKSA * RJSA * XS(10))
C
      XP(9) =    ANI3        - (RSNA * RISN * XS(9)) - (RPA * XS(9)) + (R
     1LNL * XS(6) * FRR/DS) - (RSNO * XS(9) * FRR/DS)
C
      XP(5) = (RLOP * XS(4) * SWCFR) -    ANI2        + (RLNA * RILN * XS
     1(6)) + (PPTA/DSL) - (RLAL * XS(5) * FRR/DSL) - (RLAL * XS(5) * QES
     2/(A * DSL)) + (RLAL * XS(2) * FRR/DSL)
C
      XP(10) = (RKAS * RJAS * XS(8)) - (RSN * SSED * (1.0 - FR) * XS(10)
     1/(A * DS * SGS)) - (RKSA * RJSA * XS(10))
C
      XP(11) = (ROM * SSED * FR * XS(1)/SGL) + (RLNH * XS(2) * SQ) + (RL
     1NO * XS(3) * SQ) + (RSN * SSED * (1.0 - FR) * XS(10)/SGS) + (RLNL
     2* XS(6) * QES) + (ROM * SSED * FR * XS(4)/SGL) + (RLAL * XS(5) * Q
     3ES)
      IF ((INK .NE. 0) .AND. (SSED .GT. 0.1)) CALL POLUT (FR,3,3,ROM,RSN
     1,SGL,SKP,XP,XS)
      GO TO 110
  100 XP(1) =  - (RLOP * XS(1) * SWCFR) - (ROM * SSED * XS(1)/(A * DL *
     1SGS))
C
      XP(4) =  - (RLOP * XS(4) * SWCFR) - (ROM * SSED * XS(4)/(A * DSL *
     1 SGS))
C
      ANI1 = RSAN * RILA * XS(2)
      XP(2) = (RLOP * XS(1) * SWCFR) -    ANI1        + (RSNA * RILN * XS
     1(3)) + (PPTA/DL) - (RLNH * XS(2) * SQ/(A * DL)) - (RSNH * XS(2) *
     2FRR/DL) - (RSN * SSED * XS(2)/(A * DL * SGS))
```

D-125

```
C
      XP(3) =    ANI1        - (RSNA * RILN * XS(3)) + (PPTN/DL) - (RLNO
     1* XS(3) * SQ/(A * DL)) - (RSNO * XS(3) * FRR/DL)
C
      ANI2 = RSAN * RILA * XS(5)
      XP(6) =    ANI2        - (RSNA * RILN * XS(6)) + (PPTN/DSL) - (RSNO
     1 * XS(6) * FRR/DSL) + (RSNO * XS(3) * FRR/DSL) - (RSNO * XS(6) * Q
     2ES/(A * DSL))
C
      ANI3 = RSAN * RISA * XS(8)
      XP(8) = (RSNA * RISN * XS(9)) -    ANI3        - (RPA * XS(8)) - (R
     1KAS * RJAS * XS(8)) + (RSNH * XS(5) * FRR/DS) - (RSNH * XS(8) * FR
     2R/DS) + (RKSA * RJSA * XS(10))
C
      XP(9) =    ANI3        - (RSNA * RISN * XS(9)) - (RPA * XS(9)) + (R
     1SNO * XS(6) * FRR/DS) - (RSNO * XS(9) * FRR/DS)
C
      XP(5) = (RLOP * XS(4) * SWCFR) -    ANI2        + (RSNA * RILN * XS
     1(6)) + (PPTA/DSL) - (RSNH * XS(5) * FRR/DSL) - (RSNH * XS(5) * QES
     2/(A * DSL)) + (RSNH * XS(2) * FRR/DSL) - (RSN * SSED * XS(5)/(A *
     3DSL * SGS))
C
      XP(10) = (RKAS * RJAS * XS(8)) - (RKSA * RJSA * XS(10))
C
      XP(11) = (ROM * SSED * XS(1)/SGS) + (RLNH * XS(2) * SQ) + (RLNO *
     1XS(3) * SQ) + (RSN * SSED * XS(2)/SGS) + (RSNO * XS(6) * QES) + (R
     2SN * SSED * XS(5)/SGS) + (ROM * SSED * XS(4)/SGS) + (RSNH * XS(5)
     3* QES)
C
      IF ((INK .NE. 0) .AND. (SSED .GT. 0.1)) CALL POLUT (1.0,2,3,ROM,RD
     1UM,SGS,SKP,XP,XS)
  110 XP(7) = (RPA * (XS(8) + XS(9))/DS) - (RLITR * F1/3650000.0)*XS(7)
C
      XP(12) = (RLNO * XS(3) * SQ)
C
      XP(13) = (RLNH * XS(2) * SQ)
C
      XP(14) = (RSNH * XS(8) + RSNO * XS(9)) * FRR * A
      RETURN
      END
```

SUBROUTINE INPP (XP)

```
      SUBROUTINE INPP (XP)
C
C     THIS PROGRAM UNIT CALCULATES THE CHANGES IN THE PHOSPHORUS CYCLE.
C
      COMMON /ARAYS/        FDNEW(50)    , FDOLD(50)    , HQS(2,50)    ,
     1        NDACH(24)   , SCON(10)     , SGBB(10)     , SIZE(10)     ,
     2        SKP(3,10)   , SKPP(3,10)   , SSEM(10)     , SSEW(10)     ,
     3        TEMP(366)   , TITLE(20)    , XS(14)       , XT(11)
      COMMON /BLOCK/        A            , AI           , AL           ,
     1        B           , DO           , DECAY        , DENOM        ,
     2        DL          , DS           , DSL          , DT           ,
     3        E1          , E2           , E3           , E4           ,
     4        E5          , E6           , F1           , F2           ,
     5        FR          , FRA          , FRR          , GG           ,
     6        H           , IND          , INK          , ITCOM        ,
     7        JCHAN       , MM           , NDX          , NOPL         ,
     8        NUMCH       , PPTA         , PPTN         , PPTP         ,
     9        QES         , RILA         , RILN         , RISA         ,
     A        RISN        , RITM1        , RJAS         , RJSA         ,
     B        RKAS        , RKP          , RKPS         , RKPST        ,
     C        RKSA        , RKSP         , RKSPT        , RLAL         ,
     D        RLAN        , RLIT         , RLITR        , RLNA         ,
```

D-126

```
      E        RLNH        , RLNL        , RLNO        , RLOM        ,
      F        RLOMT       , RLOP        , RLP         , RLPL        ,
      G        ROM         , ROR         , RPA         , RSAN        ,
      H        RSN         , RSNA        , RSNH        , RSNO        ,
      I        RSP         , RSPL        , SGL         , SGS         ,
      J        SLEN        , SQ          , SSED        , SUMX
       DIMENSION            XP(11)
C
C      SYSTEM EQUATIONS USED IN THE PHOSPHORUS CYCLE MODELING FOR THE
C      STUDIED WATERSHED WERE AS FOLLOW.
C
       IF (IND .EQ. 0) GO TO 100
       XP(1) = (RLITR * F2 * (DT * RITM1 * (1.0 - EXP ( - DT * RITM1 * DE
      1CAY)) + DT * (1.0 - EXP ( - DT * DECAY)))/(DL * 3650000.0)) - (ROR
      2 * SSED * FR * XT(1)/(A * DL * SGL)) - (RLOM * RLOMT * XT(1))
C
       XP(3) = (RLITR * F2 * (DT * RITM1 * (1.0 - EXP ( - DT * RITM1 * DE
      1CAY)) + DT * (1.0 - EXP ( - DT * DECAY)))/(DSL * 3650000.0)) - (RO
      2R * SSED * FR * XT(3)/(A * DSL * SGL)) - (RLOM * RLOMT * XT(3))
C
       XP(2) = (RLOM * RLOMT * XT(1)) + (PPTP/DL) - (RLP * XT(2) * SQ/(A
      1* DL)) - (RLPL * XT(2) * FRR/DL)
C
       XP(4) = (RLOM * RLOMT * XT(3)) + (PPTP/DSL) + (RLPL * XT(2) * FRR
      1/DSL) - (RLPL * XT(4) * FRR/DSL) - (RLPL * XT(4) * QES/(A * DSL))
C
       XP(6) = (RLPL * XT(4) * FRR/DS) + (RKSP * RKSPT * XT(7)) - (RKPS *
      1 RKPST * XT(6)) - (RKP * XT(5)) - (RSPL * XT(6) * FRR/DS)
C
       XP(7) = (RKPS * RKPST * XT(6)) - (RKSP * RKSPT * XT(7)) - (RSP * S
      1SED * (1.0 - FR) * XT(7)/(A * DS * SGS))
C
       XP(8) = (RLP * XT(2) * SQ) + (ROR * SSED * FR * (XT(1) + XT(3))/SG
      1L) + (RLPL * XT(4) * QES) + (RSP * SSED * (1.0 - FR) * XT(7)/SGS)
C
       XP(9) = (RSP * SSED * (1.0 - FR) * XT(7)/SGS) + (ROR * SSED * FR *
      1 (XT(1) + XT(3))/SGL)
       IF ((INK .NE. 0) .AND. (SSED .GT. 0.1)) CALL POLUT (FR,3,2,ROR,RSP
      1,SGL,SKPP,XP,XT)
C
       GO TO 110
  100  XP(1) =  - (RLOM * RLOMT * XT(1)) - (ROR * SSED * XT(1)/(A * DL *
      1SGS))
C
       XP(3) =  - (RLOM * RLOMT * XT(3)) - (ROR * SSED * XT(3)/(A * DSL *
      1 SGS))
C
       XP(2) = (RLOM * RLOMT * XT(1)) + (PPTP/DL) - (RLP * XT(2) * SQ/(A
      1* DL)) - (RSPL * XT(2) * FRR/DL) - (RSP * SSED * XT(2)/(A * DL * S
      2GS))
C
       XP(4) = (RLOM * RLOMT * XT(3)) + (PPTP/DSL) + (RSPL * XT(2) * FRR
      1/DSL) - (RSPL * XT(4) * FRR/DSL) - (RSPL * XT(4) * QES/(A * DSL))
      2- (RSP * SSED * XT(4)/(A * DSL * SGS))
C
       XP(6) = (RSPL * XT(4) * FRR/DS) + (RKSP * RKSPT * XT(7)) - (RKPS *
      1 RKPST * XT(6)) - (RKP * XT(5)) - (RSPL * XT(6) * FRR/DS)
C
       XP(7) = (RKPS * RKPST * XT(6)) - (RKSP * RKSPT * XT(7))
C
       XP(8) = (RLP * XT(2) * SQ) + (ROR * SSED * (XT(1) + XT(3))/SGS) +
      1(RSPL * XT(4) * QES) + (RSP * SSED * (XT(2) + XT(4))/SGS)
C
       XP(9) = (RSP * (XT(2) + XT(4)) + ROR * (XT(1) + XT(3))) * SSED/SGS
       IF ((INK .NE. 0) .AND. (SSED .GE. 0.1)) CALL POLUT (1.0,2,2,ROR,RD
      1UM,SGS,SKPP,XP,XT)
C
  110  XP(5) = (RKP * XT(5)/DS) - (RLITR * F2/3650000.0)*XT(5)
C
       XP(10) = (RLP * XT(2) * SQ)
C
       XP(11) = (RSPL * XT(6) * FRR * A)
       RETURN
       END
```

D-127

SUBROUTINE NITRO

```
      SUBROUTINE NITRO
C
C     THIS PROGRAM UNIT SIMULATES THE NITROGEN CYCLE.
C
      COMMON /ARAYS/        FDNEW(50)   , FDOLD(50)   , HQS(2,50)   ,
     1        NDACH(24)   , SCON(10)    , SGBB(10)    , SIZE(10)    ,
     2        SKP(3,10)   , SKPP(3,10)  , SSEM(10)    , SSEW(10)    ,
     3        TEMP(366)   , TITLE(20)   , XS(14)      , XT(11)
      COMMON /BLOCK/        A           , AI          , AL          ,
     1        B           , DO          , DECAY       , DENOM       ,
     2        DL          , DS          , DSL         , DT          ,
     3        E1          , E2          , E3          , E4          ,
     4        E5          , E6          , F1          , F2          ,
     5        FR          , FRA         , FRR         , GG          ,
     6        H           , IND         , INK         , ITCOM       ,
     7        JCHAN       , MM          , NDX         , NOPL        ,
     8        NUMCH       , PPTA        , PPTN        , PPTP        ,
     9        QES         , RILA        , RILN        , RISA        ,
     A        RISN        , RITM1       , RJAS        , RJSA        ,
     B        RKAS        , RKP         , RKPS        , RKPST       ,
     C        RKSA        , RKSP        , RKSPT       , RLAL        ,
     D        RLAN        , RLIT        , RLITR       , RLNA        ,
     E        RLNH        , RLNL        , RLNO        , RLOM        ,
     F        RLOMT       , RLOP        , RLP         , RLPL        ,
     G        ROM         , ROR         , RPA         , RSAN        ,
     H        RSN         , RSNA        , RSNH        , RSNO        ,
     I        RSP         , RSPL        , SGL         , SGS         ,
     J        SLEN        , SQ          , SSED        , SUMX
      DIMENSION             WK(56)
      LOGICAL               BE          , BH          , BR          ,
     1        BX
C
C     ERR5 SHOULD BE SET TO 0.5 TIMES THE DESIRED RELATIVE PRECISION
C     OF THE SOLUTION.
C
      DATA    ERR5 /0.5E - 4/
      N = 14
      IF (AI - B) 100,300,100
  100 IB1 = N + N
      IB2 = IB1 + N
      HMIN = 0.01 * ABS (H)
      BH = .TRUE.
      BR = .TRUE.
      BX = .TRUE.
C
C     CHECK FOR THE PROPER SIGN OF H.
C
      H = SIGN (ABS (H),B - AI)
      X = AI
  110 XSS = X
      DO 120 LP120 = 1,N
         IJKO = N + LP120
         WK(IJKO) = XS(LP120)
  120 CONTINUE
  130 HS = H
      Q = X + H - B
      BE = .TRUE.
      IF ( .NOT. (((H .GT. 0.0) .AND. (Q .GE. 0.0)) .OR. ((H .LT. 0.0) .
     1AND. (Q.LE.0.0)))) GO TO 140
      H = B - X
      BR = .FALSE.
  140 H3 = H/3.0
```

```
C
C     CALCULATE SOLUTION AT X + H.
C
      DO 280 LP280 = 1,5
         CALL INPN (WK)
         DO 240 LP240 = 1,N
            Q = H3 * WK(LP240)
            IJK0 = N + LP240
            IJK1 = IB1 + LP240
            IJK2 = IB2 + LP240
            GO TO (150,160,170,180,190), LP280
  150       R = Q
            WK(IJK1) = Q
            GO TO 200
  160       R = 0.5 * (Q + WK(IJK1))
            GO TO 200
  170       R = 3.0 * Q
            WK(IJK2) = R
            R = 0.375 * (R + WK(IJK1))
            GO TO 200
  180       R = WK(IJK1) + 4.0 * Q
            WK(IJK1) = R
            R = 1.5 * (R - WK(IJK2))
            GO TO 200
  190       R = 0.5 * (Q + WK(IJK1))
            Q = ABS (R + R - 1.5 * (Q + WK(IJK2)))
  200       XS(LP240) = WK(IJK0) + R
            IF (LP280 .NE. 5) GO TO 240
C
C     AUTOMATIC STEP CHANGE.
C
            E = ABS (XS(LP240))
            R = ERR5
            IF (E .GE. 1.0E - 3) R = E * ERR5
C
C     TEST ADJUSTMENT OF THE STEP.
C
            IF ((Q .LT. R) .OR. ( .NOT. BX)) GO TO 230
            BR = .TRUE.
            BH = .FALSE.
            H = 0.5 * H
            IF (ABS (H) .GE. HMIN) GO TO 210
C
C     THE STEP IS HALVED, RESTORE X AND XS, AND GO BACK FOR REPEATED
C     INTEGRATION WITH THIS NEW STEP.
C
            H = SIGN (1.0,H) * HMIN
            BX = .FALSE.
  210       DO 220 LP220 = 1,N
               IJK0 = N + LP220
               XS(LP220) = WK(IJK0)
  220       CONTINUE
            X = XSS
            GO TO 130
  230       IF (Q .GE. (0.03125 * R)) BE = .FALSE.
  240    CONTINUE
         GO TO (250,280,260,270,280), LP280
  250    X = X + H3
         GO TO 280
  260    X = X + 0.5 * H3
         GO TO 280
  270    X = X + 0.5 * H
  280 CONTINUE
C
C     TEST A POSSIBLE DOUBLING OF THE STEP.
C
      IF ( .NOT. (BE .AND. BH .AND. BR)) GO TO 290
      H = H + H
      BX = .TRUE.
  290 BH = .TRUE.
      IF (BR) GO TO 110
      H = HS
      IF (BX .OR. BE) GO TO 320
      WRITE (97,330)
      GO TO 320
  300 DO 310 LP310 = 1,N
         XS(LP310) = 0.0
  310 CONTINUE
  320 RETURN
C
C     VARIOUS FORMATS.
C
  330 FORMAT (20X,34HCHECK YOUR DATA (NOTE FROM NITRO).)
      END
```

SUBROUTINE PHOS

```
      SUBROUTINE PHOS
C
C     THIS PROGRAM UNIT SIMULATES THE PHOSPORUS CYCLE.
C
      COMMON /ARAYS/        FDNEW(50)   , FDOLD(50)   , HQS(2,50)   ,
     1        NDACH(24)   , SCON(10)    , SGBB(10)    , SIZE(10)    ,
     2        SKP(3,10)   , SKPP(3,10)  , SSEM(10)    , SSEW(10)    ,
     3        TEMP(366)   , TITLE(20)   , XS(14)      , XT(11)
      COMMON /BLOCK/        A           , AI          , AL          ,
     1        B           , DO          , DECAY       , DENOM       ,
     2        DL          , DS          , DSL         , DT          ,
     3        E1          , E2          , E3          , E4          ,
     4        E5          , E6          , F1          , F2          ,
     5        FR          , FRA         , FRR         , GG          ,
     6        H           , IND         , INK         , ITCOM       ,
     7        JCHAN       , MM          , NDX         , NOPL        ,
     8        NUMCH       , PPTA        , PPTN        , PPTP        ,
     9        QES         , RILA        , RILN        , RISA        ,
     A        RISN        , RITM1       , RJAS        , RJSA        ,
     B        RKAS        , RKP         , RKPS        , RKPST       ,
     C        RKSA        , RKSP        , RKSPT       , RLAL        ,
     D        RLAN        , RLIT        , RLITR       , RLNA        ,
     E        RLNH        , RLNL        , RLNO        , RLOM        ,
     F        RLOMT       , RLOP        , RLP         , RLPL        ,
     G        ROM         , ROR         , RPA         , RSAN        ,
     H        RSN         , RSNA        , RSNH        , RSNO        ,
     I        RSP         , RSPL        , SGL         , SGS         ,
     J        SLEN        , SQ          , SSED        , SUMX
      DIMENSION             WK(44)
      LOGICAL               BE          , BH          , BR          ,
     1        BX
C
C     ERR5 SHOULD BE SET TO 0.5 TIMES THE DESIRED RELATIVE PRECISION
C     OF THE SOLUTION.
C
      DATA    ERR5 /0.5E - 4/
      N = 11
      IF (AI - B) 100,300,100
  100 IB1 = N + N
      IB2 = IB1 + N
      HMIN = 0.01 * ABS (GG)
      BH = .TRUE.
      BR = .TRUE.
      BX = .TRUE.
C
C     CHECK FOR THE PROPER SIGN OF H.
C
      GG = SIGN (ABS (GG),B - AI)
      X = AI
  110 XSS = X
      DO 120 LP120 = 1,N
         IJKO = N + LP120
         WK(IJKO) = XT(LP120)
  120 CONTINUE
  130 HS = GG
      Q = X + GG - B
      BE = .TRUE.
      IF ( .NOT. (((GG .GT. 0.0) .AND. (Q .GE. 0.0)) .OR. ((GG .LT. 0.0)
     1 .AND. (Q .LE. 0.0)))) GO TO 140
      GG = B - X
      BR = .FALSE.
  140 H3 = GG/3.0
C
C     CALCULATE SOLUTION AT X + H.
C
```

```
      DO 280 LP280 = 1,5
         CALL INPP (WK)
         DO 240 LP240 = 1,N
            Q = H3 * WK(LP240)
            IJK0 = N + LP240
            IJK1 = IB1 + LP240
            IJK2 = IB2 + LP240
            GO TO (150,160,170,180,190), LP280
 150        R = Q
            WK(IJK1) = Q
            GO TO 200
 160        R = 0.5 * (Q + WK(IJK1))
            GO TO 200
 170        R = 3.0 * Q
            WK(IJK2) = R
            R = 0.375 * (R + WK(IJK1))
            GO TO 200
 180        R = WK(IJK1) + 4.0 * Q
            WK(IJK1) = R
            R = 1.5 * (R - WK(IJK2))
            GO TO 200
 190        R = 0.5 * (Q + WK(IJK1))
            Q = ABS (R + R - 1.5 * (Q + WK(IJK2)))
 200        XT(LP240) = WK(IJK0) + R
            IF (LP280 .NE. 5) GO TO 240
C
C     AUTOMATIC STEP CHANGE.
C
            E = ABS (XT(LP240))
            R = ERR5
            IF (E .GE. 1.0E - 3) R = E * ERR5
C
C     TEST ADJUSTMENT OF THE STEP.
C
            IF ((Q .LT. R) .OR. ( .NOT. BX)) GO TO 230
            BR = .TRUE.
            BH = .FALSE.
            GG = 0.5 * GG
            IF (ABS (GG) .GE. HMIN) GO TO 210
C
C     THE STEP IS HALVED, RESTORE X AND XT, AND GO BACK FOR REPEATED
C     INTEGRATION WITH THIS NEW STEP.
C
            GG = SIGN (1.0,GG) * HMIN
            BX = .FALSE.
 210        DO 220 LP220 = 1,N
               IJK0 = N + LP220
               XT(LP220) = WK(IJK0)
 220        CONTINUE
            X = XSS
            GO TO 130
 230        IF (Q .GE. (0.03125 * R)) BE = .FALSE.
 240     CONTINUE
         GO TO (250,280,260,270,280), LP280
 250     X = X + H3
         GO TO 280
 260     X = X + 0.5 * H3
         GO TO 280
 270     X = X + 0.5 * GG
 280 CONTINUE
C
C     TEST A POSSIBLE DOUBLING OF THE STEP.
C
      IF ( .NOT. (BE .AND. BH .AND. BR)) GO TO 290
      GG = GG + GG
      BX = .TRUE.
 290  BH = .TRUE.
      IF (BR) GO TO 110
      GG = HS
      IF (BX .OR. BE) GO TO 320
      WRITE (97,330)
      GO TO 320
```

```
  300 DO 310 LP310 = 1,N
        XT(LP310) = 0.0
  310 CONTINUE
  320 RETURN
C
C     VARIOUS FORMATS.
C
  330 FORMAT (20X,33HCHECK YOUR DATA (NOTE FROM PHOS).)
      END
```

SUBROUTINE POLUT (FPLT, NCAL, NSEP, RA, RB, SGPLT, SKPLT, XP, XXP)

```
      SUBROUTINE POLUT (FPLT,NCAL,NSEP,RA,RB,SGPLT,SKPLT,XP,XXP)
      COMMON /ARAYS/        FDNEW(50)   , FDOLD(50)   , HOS(2,50)   ,
     1       NDACH(24)    , SCON(10)    , SGBB(10)    , SIZE(10)    ,
     2       SKP(3,10)    , SKPP(3,10)  , SSEM(10)    , SSEW(10)    ,
     3       TEMP(366)    , TITLE(20)   , XS(14)      , XT(11)
      COMMON /BLOCK/        A           , AI          , AL          ,
     1       B            , DO          , DECAY       , DENOM       ,
     2       DL           , DS          , DSL         , DT          ,
     3       E1           , E2          , E3          , E4          ,
     4       E5           , E6          , F1          , F2          ,
     5       FR           , FRA         , FRR         , GG          ,
     6       H            , IND         , INK         , ITCOM       ,
     7       JCHAN        , MM          , NDX         , NOPL        ,
     8       NUMCH        , PPTA        , PPTN        , PPTP        ,
     9       QES          , RILA        , RILN        , RISA        ,
     A       RISN         , RITM1       , RJAS        , RJSA        ,
     B       RKAS         , RKP         , RKPS        , RKPST       ,
     C       RKSA         , RKSP        , RKSPT       , RLAL        ,
     D       RLAN         , RLIT        , RLITR       , RLNA        ,
     E       RLNH         , RLNL        , RLNO        , RLOM        ,
     F       RLOMT        , RLOP        , RLP         , RLPL        ,
     G       ROM          , ROR         , RPA         , RSAN        ,
     H       RSN          , RSNA        , RSNH        , RSNO        ,
     I       RSP          , RSPL        , SGL         , SGS         ,
     J       SLEN         , SQ          , SSED        , SUMX
      DIMENSION             XP(14)      , XXP(14)     , SKPLT(3,10)
      DO 120 LP120 = 1,NCAL
         KK120 = NSEP * (LP120 - 1 + (LP120/3)) + 1
         IF (LP120 .LE. 2) TPL = RA * SSEO * FPLT * XXP(KK120)/SGPLT
         IF (LP120 .GT. 2) TPL = RB * SSED * (1.0 - FPLT) * XXP(KK120)/S
     1   GS
         TR = TPL
         SUMS = 0.0
         SUMW = 0.0
         DO 110 LP110 = 1,MM
            TR = TR - SUMS
            IF (TR .LE. 0.0) TR = 0.0
            BFACT = SUMX * SGS/(SGS + SCON(LP110))
            CS = 0.0
            IF ((SUMX .GE. 0.001) .AND. (SSEM(LP110) .GT. 0.0)) CS = TR/
     1      (BFACT * (SCON(LP110) + 1000.0/SKPLT(LP120,LP110)))
            CW = CS/SKPLT(LP120,LP110)
            SUMS = SUMS + CS * SSEM(LP110)
            SUMW = SUMW + CW * SSEW(LP110)
  110    CONTINUE
         TFACT = TPL - (SUMS + SUMW)
         IF (NSEP .EQ. 2) XP(8) = XP(8) - TPL + SUMW
         IF (NSEP .EQ. 2) XP(9) = XP(9) - TPL + SUMS
         IF (NSEP .EQ. 3) XP(11) = XP(11) - TFACT
         FBAL1 = (2.0 - FLOAT(LP120)) * (3.0 - FLOAT(LP120))/2.0
         FBAL2 = (FLOAT(LP120) - 1.0) * (3.0 - FLOAT(LP120))
         FBAL3 = (FLOAT(LP120) - 2.0) * (FLOAT(LP120) - 1.0)/2.0
         XP(KK120) = XP(KK120) + TFACT/(A * (DL * FBAL1 + DSL * FBAL2 +
     1   DS * FBAL3))
  120 CONTINUE
      RETURN
      END
```

D-132

SUBROUTINE ROUTE

```
      SUBROUTINE ROUTE
C
C     THIS PROGRAM UNIT RUNS THE SIMULATION ON ALL WATERSHED UNITS.
C
      COMMON /ARAYS/        FDNEW(50)   , FDOLD(50)   , HOS(2,50)   ,
     1        WDACH(24)   , SCON(10)    , SGBB(10)    , SIZE(10)    ,
     2        SKP(3,10)   , SKPP(3,10)  , SSEM(10)    , SSEW(10)    ,
     3        TEMP(366)   , TITLE(20)   , XS(14)      , XT(11)
      COMMON /BLOCK/        A           , AI          , AL          ,
     1        B           , DO          , DECAY       , DENOM       ,
     2        DL          , DS          , DSL         , DT          ,
     3        E1          , E2          , E3          , E4          ,
     4        E5          , E6          , F1          , F2          ,
     5        FR          , FRA         , FRR         , GG          ,
     6        H           , IND         , INK         , ITCOM       ,
     7        JCHAN       , MM          , NDX         , NOPL        ,
     8        NUNCH       , PPTA        , PPTN        , PPTP        ,
     9        QES         , RILA        , RILN        , RISA        ,
     A        RISN        , RITM1       , RJAS        , RJSA        ,
     B        RKAS        , RKP         , RKPS        , RKPST       ,
     C        RKSA        , RKSP        , RKSPT       , RLAL        ,
     D        RLAN        , RLIT        , RLITR       , RLNA        ,
     E        RLNH        , RLNL        , RLNO        , RLOM        ,
     F        RLOMT       , RLOP        , RLP         , RLPL        ,
     G        ROM         , ROR         , RPA         , RSAN        ,
     H        RSN         , RSNA        , RSNH        , RSNO        ,
     I        RSP         , RSPL        , SGL         , SGS         ,
     J        SLEN        , SQ          , SSED        , SUMX
C
C     INITIALIZE SUMMARY VARIABLES.
C
      TRMTN = 0.0
      TRMN = 0.0
      TRMA = 0.0
      TRMTP = 0.0
      TRMO = 0.0
      TRMP = 0.0
      DO 170 LP170 = 1,NOPL
         CALL DATA2
         DO 160 LP160 = 1,ITCOM
            RITM1 = FLOAT (LP160 - 1)
            IF (LP160 .EQ. 1) GO TO 100
            XPN1 = EXP ( - DECAY * RITM1)
            XPN2 = EXP ( - DECAY)
            EFFDP = DO * XPN1 + XPN2 * (RLIT/365.0) * ((1.0 - XPN1)/(1.0
     1       - XPN2))
            RLITR = 365.0 * EFFDP/RITM1
            GO TO 110
  100       RLITR = DO * 365.0
  110       CALL DATA3 (LP160)
            NS = 0
            DO 120 LP120 = 1,MM
               IF (SIZE(LP120) .GT. 0.0062) GO TO 120
               NS = NS + 1
  120       CONTINUE
            WT = 1.0/2.0
C
C     SSED = SEDIMENT PRODUCTION RATE (KILOGRAMS PER DAY).
C
            SSED = 0.0
            IF (NS .LE. 0) GO TO 140
            DO 130 LP130 = 1,NS
               IF ((LP130 .EQ. NS) .AND. (NS .NE. 2)) WT = 1.0/2.0
               SSED = SSED + (SGBB(LP130) * WT)/86400.0
               WT = 1.0
  130       CONTINUE
```

D-133

```
          SSED = SSED * 86400.0
C
C     COMPUTE AT TIME LP160 (T + DT).
C
  140       CALL SUBSF
C
C     SIMULATE NITROGEN AND PHOSPHORUS CYCLES ON A TIME PERIOD BASIS.
C
C
            ITIME = INT (1.0/DT)
            DO 150 LP150 = 1,ITIME
               KP = LP150 + (LP160 - 1) * ITIME
               R = 1.0/FLOAT (ITIME) * FLOAT (KP)
C
C     SIMULATE NITROGEN CYCLE.
C
               CALL NITRO
C
C     SIMULATE PHOSPHORUS CYCLE.
C
               CALL PHOS
               AI = AI + DT
  150       CONTINUE
  160    CONTINUE
C
C     OUTPUT SUMMARY VALUES FOR THE PLANE.
C
         WRITE (97,180)
         WRITE (97,190) LP170,XS(11),XS(12),XS(13),XT(8),XT(9),XT(10)
         TRMTN = XS(11) + TRMTN
         TRMN = XS(12) + TRMN
         TRMA = XS(13) + TRMA
         TRMTP = XT(8) + TRMTP
         TRMO = XT(9) + TRMO
         TRMP = XT(10) + TRMP
         WRITE (53,200) (XS(IMPD5),IMPD5 = 1,14)
         WRITE (53,200) (XT(IMPD6),IMPD6 = 1,11)
         WRITE (53,200) EFFDP
  170 CONTINUE
C
C     OUTPUT SUMMARY VALUES FOR THE TOTAL SIMULATION.
C
      WRITE (97,210)
      WRITE (97,220)
      WRITE (97,230) TRMTN,TRMN,TRMA
      WRITE (97,240)
      WRITE (97,250)
      WRITE (97,230) TRMTP,TRMO,TRMP
C
C     OUTPUT SUMMARY VARIABLES.
C
      WRITE (8,260) TRMTN
      WRITE (8,260) TRMTP
C
C     OUTPUT END-OF-SUBFILE MARK FOR FILE T53XXX.
C
      END FILE 53
      RETURN
C
C     VARIOUS FORMATS.
C
  180 FORMAT (///,20X,91HNITROGEN AND PHOSPHORUS LOADINGS FROM EACH WATE
     1RSHED PLANE(AMOUNT OF NUTRIENTS IN KILOGRAM),///)
  190 FORMAT (20X,13HPLANE NUMBER=,12X,I15,/,20X,15HTOTAL NITROGEN=,10X,
     1E15.7,/,20X,8HNITRATE=,17X,E15.7,/,20X,9HAMMONIUM=,16X,E15.7,/,20X
     2,17HTOTAL PHOSPHORUS=,8X,E15.7,/,20X,19HORGANIC PHOSPHORUS=,6X,E15
     3.7,/,20X,21HINORGANIC PHOSPHORUS=,4X,E15.7,///)
  200 FORMAT (8F10.4)
  210 FORMAT (20X,48HTOTAL NITROGEN LOADINGS FROM MULTIWATERSHEDS(KG),//
     1/)
  220 FORMAT (20X,14HTOTAL NITROGEN,19X,7HNITRATE,17X,8HAMMONIUM,/)
  230 FORMAT (20X,E15.7,10X,E15.7,10X,E15.7,///)
  240 FORMAT (20X,50HTOTAL PHOSPHORUS LOADINGS FROM MULTIWATERSHEDS(KG),
     1///)
  250 FORMAT (20X,16HTOTAL PHOSPHORUS,6X,18HORGANIC PHOSPHORUS,5X,20HINO
     1RGANIC PHOSPHORUS,/)
  260 FORMAT (2X,G30.10)
      END
```

SUBROUTINE SUBSF

```
      SUBROUTINE SUBSF
C
C     THIS PROGRAM UNIT CALCULATES THE SUBSURFACE WATER FLOW.
C
      COMMON /ARAYS/        FDNEW(50)    , FDOLD(50)    , HQS(2,50)    ,
     1        NDACH(24)    , SCON(10)    , SGBB(10)     , SIZE(10)     ,
     2        SKP(3,10)    , SKPP(3,10)  , SSEM(10)     , SSEW(10)     ,
     3        TEMP(366)    , TITLE(20)   , XS(14)       , XT(11)
      COMMON /BLOCK/        A             , AI           , AL           ,
     1        B            , DO          , DECAY        , DENOM        ,
     2        DL           , DS          , DSL          , DT           ,
     3        E1           , E2          , E3           , E4           ,
     4        E5           , E6          , F1           , F2           ,
     5        FR           , FRA         , FRR          , GG           ,
     6        H            , IND         , INK          , ITCOM        ,
     7        JCHAN        , MM          , NDX          , NOPL         ,
     8        NUMCH        , PPTA        , PPTN         , PPTP         ,
     9        QES          , RILA        , RILN         , RISA         ,
     A        RISN         , RITM1       , RJAS         , RJSA         ,
     B        RKAS         , RKP         , RKPS         , RKPST        ,
     C        RKSA         , RKSP        , RKSPT        , RLAL         ,
     D        RLAN         , RLIT        , RLITR        , RLNA         ,
     E        RLNH         , RLNL        , RLNO         , RLOM         ,
     F        RLOMT        , RLOP        , RLP          , RLPL         ,
     G        ROM          , ROR         , RPA          , RSAN         ,
     H        RSN          , RSNA        , RSNH         , RSNO         ,
     I        RSP          , RSPL        , SGL          , SGS          ,
     J        SLEN         , SQ          , SSED         , SUMX
      COMMON /BLOK2/        SWCFR         , THETA        , XPGP
C
C     COMPUTE THE AVERAGE INFILTRATION RATE (CENTIMETERS PER SECOND).
C
      FD = FRA/86400.0
C
C     THE VALUE OF FDNEW(LP100) IS SET EQUAL TO THE RAINFALL RATE.
C
      FDNEW(1) = FD
C
C     DISTRIBUTE THE WATER IN THE DOWNSLOPE DIRECTION.
C
      DO 100 LP100 = 2,NDX
         FDNEW(LP100) = FD
         FDAVE = (FDNEW(LP100) + FDOLD(LP100))/2.0
         OM = AL * THETA * HQS(2,LP100 - 1) + HQS(1,LP100) + 86400.0 * F
     1   DAVE
         HQS(2,LP100) = OM/DENOM
         HQS(1,LP100) = HQS(2,LP100)
         FDOLD(LP100 - 1) = FDNEW(LP100 - 1)
  100 CONTINUE
      FDOLD(NDX) = FDNEW(NDX)
C
C     QES = DISCHARGE OF SUBSURFACE FLOW (CUBIC METERS PER DAY).
C
      QES = AL * HQS(2,NDX) * A/(SLEN * 10000.0)
      IF (QES. LT. 1.0E - 12) QES = 0.0
      QES = QES * 86400.0
      RETURN
      END
```

PROGRAM OXTEMP

```
      BLOCK DATA
C
C     DECLARATION OF COMMON BLOCKS IN THE PROGRAM OXTMP.
C
      COMMON /ARAYS/        RA(540)
      COMMON /BLOCK/        RB(26)      , IB(3)
      END
      PROGRAM OXTEMP
     1(INPUT,OUTPUT,TAPE3=513,TAPE4=513,TAPE5=65,TAPE7=OUTPUT,TAPE8=65,T
     2APE9=65,TAPE95=INPUT)
C
C     THIS IS THE DISSOLVED OXYGEN AND TEMPERATURE LOADING MODEL.
C
C     ***************************************************************
C     INPUT AND OUTPUT DICTIONARY.
C     ***************************************************************
C
C     INPUT FILES
C        READ (3)       = RUNXXX
C        READ (4)       = OXHXXX
C        READ (5,FM)    = CONXXX
C        READ (8,FM)    = OXCXXX
C        READ (95,FM)   = OYTXXX
C
C     OUTPUT FILES
C        WRITE (7,FM)   = LINE PRINTER
C        WRITE (9,FM)   = OXTXXX
C
C     ***************************************************************
C
      COMMON /BLOCK/        AREA        , BA          , CANCV       ,
     1        DLT         , DT          , DZ          , ELEN1       ,
     2        ELEN2       , ENG         , GRNCV       , IM          ,
     3        NOPL        , NSTOM       , R1          , R3          ,
     4        SPGA        , SPHE        , STE         , STIME       ,
     5        SUM1        , SUMD1       , SUMH1       , TA1         ,
     6        TA2         , TDEP        , TEM         , THCO        ,
     7        TOTDP       , U
C
C     CALL THE INPUT ROUTINE.
C
      CALL INPT
C
C     INITIALIZE YEAR TOTALS.
C
      TTMLD = 0.0
      TDSXY = 0.0
C
C     RUN THE PROGRAM FOR EVERY STORM EVENT.
C
      DO 31 LP31 = 1,NSTOM
         TTVL = 0.0
         SUU = 0.0
         SUUH = 0.0
         SUMD = 0.0
C
C     RUN THE STORM EVENT ON EACH PLANE.
C
         DO 21 LP21 = 1,NOPL
C
C     TOTVL = TOTAL VOLUME OF RUNOFF (CENTIMETERS).
C
C     TW = SURFACE WATER TEMPERATURE (DEGREES CELSIUS).
C
C     STIME = SOLAR RADIATED PERIOD (HOURS).
C
         READ (3) ISTAT,ISTOR,TOTVL,ELEN1,ELEN2,TA1,TA2,TW,STIME,CANC
     1   V,GRNCV
```

D-136

```
C
C     COMPUTE THE AVERAGE TEMPERATURE FOR RUNOFF WATER.
C
            CALL TMCAL (LP31,LP21)
C
C     COMPUTE THE AVERAGE DISSOLVED OXYGEN IN RUNOFF WATER.
C
            CALL DISOX (LP31,LP21)
C
C     COMPUTE PLANAR TOTALS.
C
            SUU = SUU + SUM1
            SUUH = SUUH + SUMH1
            SUMD = SUMD + SUMD1
            TTVL = AREA * TOTVL/100.0 + TTVL
   21    CONTINUE
C
C     COMPUTE STORM TOTALS.
C
         TRR = SUUH/(SUU * 1000.0)
         TEMLD = TTVL * (TRR - TW) * 1000.0 * 4.184
         DSOXY = SUMD/SUU
         TTMLD = TTMLD + TEMLD
         TDSXY = TDSXY + DSOXY * SUU
C
C     OUTPUT THE RESULTS TO THE LINE PRINTER.
C
         WRITE (7,51) LP31,TW,TRR,TEMLD,DSOXY
   31 CONTINUE
C
C     OUTPUT SUMMARY OF YEARLY TOTALS.
C
      WRITE (9,61) TDSXY
      WRITE (9,61) TTMLD
C
C     TERMINATE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
   41 FORMAT (/20X,17HBAD OPEN FOR FILE,1X,3A2,1X,33HRUN TERMINATED FOR
     1PROGRAM OXTMP.)
   51 FORMAT (////,20X,13HSTORM NUMBER=,17X,I10,//,20X,30HSURFACE WATER
     1TEMPERATURE(C)= ,E10.3,//,20X,30HRUNOFF WATER TEMPERATURE(C)=  ,E1
     20.3,//,20X,20HTHERMAL LOADING(KJ)=,10X,E10.3,//,20X,30HAVERAGE DIS
     3SOLVED OXYGEN(MG)= ,E10.3,/////)
   61 FORMAT (2X,G30.10)
      END
```

SUBROUTINE COND (M, N)

```
      SUBROUTINE COND (M,N)
      COMMON /ARRAYS/        ALT(20)      , QL(200)      , RESIS(20)    ,
     1        SLGTH(20)     , SLLG3(20)   , SLOPE(20)    , TRCAN(20)    ,
     2        TRGRN(20)     , TSUM1(200)
      COMMON /BLOCK/         AREA         , BA           , CANCV        ,
     1        DLT           , DT          , DZ           , ELEN1        ,
     2        ELEN2         , ENG         , GRNCV        , IM           ,
     3        NOPL          , NSTOM       , R1           , R3           ,
     4        SPGA          , SPHE        , STE          , STIME        ,
     5        SUM1          , SUMD1       , SUMH1        , TA1          ,
     6        TA2           , TDEP        , TEM          , THCO         ,
     7        TOTDP         , U
```

D-137

```
      COMMON /EMBLK/        DEPTT(200,20)            , QQ(200,20)  ,
     1        TSS(201,20) , TWW(201,20)
      DIMENSION             DEPT(200)
      TR = TA2 - 2.0
C
C     DT = TIME INTERVAL FOR THE TEMPERATURE AND DISSOLVED OXYGEN
C          ROUTING (MINUTES).
C
      READ (4) DT,IM,(QL(IMPD1),IMPD1 = 1,IM)
      MM = IM + 1
C
C     CALCULATE VISCOSITY.
C
      VISC = 1.10E - 6
C
C     CALCULATE DEPTH OF SURFACE FLOW.
C
      DO 110 LP110 = 1,IM
         IF (QL(LP110) .LE. 1.0E - 38) GO TO 100
         DEPT(LP110) = QL(LP110) *  * (1.0/3.0) * 1.0/(8.0 * 9.80 * SLOP
     1   E(N)/RESIS(N)/VISC) *  * (1.0/3.0)
         GO TO 110
  100    DEPT(LP110) = 0.0
  110 CONTINUE
      TDEP = 0.0
      DO 120 LP120 = 1,IM
         TDEP = TDEP + DEPT(LP120)
  120 CONTINUE
      TDEP = TDEP/FLOAT (IM)
      IF (TDEP .EQ. 0.0) WRITE (7,220) M,N
      IF (TDEP .EQ. 0.0) GO TO 210
      U = 8.0 * 9.80 * TDEP *  * 2.0 * SLOPE(N)/RESIS(N)/VISC
      AREAA = SLLG3(N) * SLGTH(N)/20.0
      DO 140 LP140 = 1,IM
         DO 130 LP130 = 1,20
            DEPTT(LP140,LP130) = DEPT(LP140)/20.0 * FLOAT (LP130)
  130    CONTINUE
  140 CONTINUE
      DO 170 LP170 = 1,20
         TSS(1,LP170) = STE
         TWW(1,LP170) = TR
         DO 160 LP160 = 2,MM
            II160 = LP160 - 1
            IF (DEPTT(II160,LP170) .GT. 1.0E - 2) GO TO 150
            QQ(II160,LP170) = 0.0
            TSS(LP160,LP170) = TSS(II160,LP170)
            TWW(LP160,LP170) = TWW(II160,LP170)
            GO TO 160
  150       THCOR = 1.0/((DEPTT(II160,LP170)/(2.0 * 11429.1)) + (TOTDP/(
     1      2.0 * THCO)))
            QQ(II160,LP170) =  - THCOR * AREAA * (DT/1440.0) * (TWW(II16
     1      0,LP170) - TSS(II160,LP170))
            TSS(LP160,LP170) = TSS(II160,LP170) - QQ(II160,LP170)/(TOTDP
     1       * SPHE * AREAA * SPGA * 1000000.0)
            TWW(LP160,LP170) = TWW(II160,LP170) + QQ(II160,LP170)/(DEPTT
     1      (II160,LP170) * AREAA * 1000000.0)
  160    CONTINUE
  170 CONTINUE
      DO 200 LP200 = 2,MM
         II200 = LP200 - 1
         SUMX1 = 0.0
         SUMX2 = 0.0
         DO 180 LP180 = 1,20
            SUMX1 = SUMX1 + TWW(II200,LP180) * DEPTT(II200,LP180)
            SUMX2 = SUMX2 + DEPTT(II200,LP180)
  180    CONTINUE
         IF ((SUMX1 .EQ. 0.0) .OR. (SUMX2 .EQ. 0.0)) GO TO 190
         TSUM1(II200) = SUMX1/SUMX2
         GO TO 200
  190    TSUM1(II200) = TR
  200 CONTINUE
  210 CONTINUE
```

D-132

```
      RETURN
C
C     VARIOUS FORMATS.
C
  220 FORMAT (/////,20X,41HSURFACE FLOW IS TOO SMALL, NO TEMPARATURE,/,2
     10X,19HROUTING IS EXECUTED,/,20X,10HSTORM NO.=,I10,/,20X,10HPLANE N
     20.=,I10,///)
      END
```

SUBROUTINE DISOX (M, N)

```
      SUBROUTINE DISOX (M,N)
      COMMON /ARAYS/        ALT(20)      , DL(200)      , RESIS(20)    ,
     1        SLGTH(20)    , SLLG3(20)   , SLOPE(20)    , TRCAN(20)    ,
     2        TRGRN(20)    , TSUM1(200)
      COMMON /BLOCK/        AREA         , BA           , CANCV        ,
     1        DLT          , DT          , DZ           , ELEN1        ,
     2        ELEN2        , ENG         , GRNCV        , IM           ,
     3        NOPL         , NSTOM       , R1           , R3           ,
     4        SPGA         , SPHE        , STE          , STIME        ,
     5        SUM1         , SUMD1       , SUMH1        , TA1          ,
     6        TA2          , TDEP        , TEM          , THCO         ,
     7        TOTDP        , U
      DIMENSION             BOD(201)     , DI(201)      , DO(201)      ,
     1        DOB(201)
      IF (TDEP .EQ. 0.0) WRITE (7,190) M,N
      IF (TDEP .EQ. 0.0) GO TO 180
      DDT = DT/1440.0
      IF (TDEP .LT. 0.1) GO TO 100
      DM = 2.037 * 1.037 *  * (TEM - 20.0)/10.0 *  * 5.0 * 8.64
      R2 = (DM * U * 86400.0) *  * 0.5/(TDEP/2.0) *  * (3.0/2.0)
      GO TO 110
  100 R2 = 180.0
  110 IF (TEM .GT. 20.0) GO TO 120
      THETA = 1.065 - 0.0012 * (TEM - 5.0)
      GO TO 130
  120 THETA = 1.047
  130 R1T = R1 * THETA *  * (TEM - 20.0)
C
C     CALCULATE THE BOD IN EACH TIME INCREMENT.
C
      BOD(1) = 0.0
      DO 140 LP140 = 1,IM
         DT1 = DDT * FLOAT (LP140)
         XP1 = EXP (- (R1T + R3) * DT1)
         BOD(LP140 + 1) = BOD(LP140) * XP1 + BA/(R1T + R3) * (1.0 - XP1)
  140 CONTINUE
C
C     CALCULATE THE OXYGEN DEFICIT IN EACH TIME INCREMENT.
C
      DI(1) = 0.0
      DOB(1) = 0.0
      DO 150 LP150 = 1,IM
         DT2 = DDT * FLOAT (LP150)
         XP2 = EXP ( - (R1T + R3) * DT2)
         XP3 = EXP ( - R2 * DT2)
         DI(LP150 + 1) = (R1T * (BOD(LP150) - BA/(R1T + R3)) * (XP2 - XP
     1   3))/(R2 - (R1T + R3)) + DI(LP150) * XP3 + (DOB(LP150)/R2 + R1T
     2   * BA/R2/(R1T + R3)) * (1.0 - XP3)
         DOB(LP150 + 1) = R2 * (DI(LP150 + 1) - DI(LP150) * XP3)/(1.0 -
     1   XP3) - R1T * BOD(LP150)
  150 CONTINUE
```

D-139

```
C
C     CALCULATE THE DISSOLVED OXYGEN.
C
      DO 160 LP160 = 1,IM
         II160 = LP160 + 1
C
C     CALCULATE ATMOSPHERIC PRESSURE (MILLIMETERS OF MERCURY).
C
         P = 760.0 - ALT(N) * (0.0899 - ALT(N) * 3.98E - 6)
C
C     CALCULATE VAPOR PRESSURE OF WATER AT GIVEN TEMPERATURE
C     (MILLIMETERS OF MERCURY).
C
         PV = 4.578 + TSUM1(LP160) * (0.3514 + TSUM1(LP160) * (0.00734 +
     1   TSUM1(LP160) * 3.7E - 4))
C
C     CALCULATE CORRECTION FACTOR FROM PRESSURE.
C
         CF = (P - PV)/(760.0 - PV)
         CS = 14.652 - 0.41022 * TSUM1(LP160) + 0.007991 * TSUM1(LP160)
     1   * * 2.0 - 0.000077774 * TSUM1(LP160) *  * 3.0
         CS = CS * CF
         DO(II160) = CS - DI(II160)
  160 CONTINUE
C
C     CALCULATE TOTAL DISSOLVED OXYGEN.
C
      SUMD1 = 0.0
      DO 170 LP170 = 1,IM
         SUMD1 = SUMD1 + DO(LP170 + 1) * QL(LP170) * 1000.0 * DT * SLLG3
     1   (N) * 60.0
  170 CONTINUE
  180 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  190 FORMAT (/////,20X,29HSURFACE FLOW IS TOO SMALL NO ,/,20X,36HDISSOL
     1VED OXYGEN ROUTING IS EXECUTED,/,20X,10HSTORM NO.=,I10,/,20X,10HPL
     2ANE NO.=,I10,///)
      END
```

SUBROUTINE INPT

```
      SUBROUTINE INPT
      COMMON /ARAYS/          ALT(20)      , QL(200)      , RESIS(20)    ,
     1        SLGTH(20)      , SLLG3(20)    , SLOPE(20)    , TRCAN(20)    ,
     2        TRGRN(20)      , TSUM1(200)
      COMMON /BLOCK/          AREA         , BA           , CANCV        ,
     1        DLT            , DT           , DZ           , ELEN1        ,
     2        ELEN2          , ENG          , GRNCV        , IM           ,
     3        NOPL           , NSTOM        , R1           , R3           ,
     4        SPGA           , SPHE         , STE          , STIME        ,
     5        SUM1           , SUMD1        , SUMH1        , TA1          ,
     6        TA2            , TDEP         , TEM          , THCO         ,
     7        TOTDP          , U
C
C     INPUT NUMBER OF PLANES (NPL) AND NUMBER OF WATERSHEDS (NWS).
C
      READ (5,150) NPL,NWS
      NOPL = 2 * NWS + NPL
C
C     COUNT NUMBER OF STORMS.
C
      NSTOM = 0
      DO 110 LP110 = 1,370
         DO 100 LP100 = 1,NOPL
            READ (3) ISTAT
            IF (EOF(3) .NE. 0.0) GO TO 120
            IF (ISTAT .NE. LP100) WRITE (7,160) LP110,LP100,ISTAT,NOPL
            IF (ISTAT .NE. LP100) CALL EXIT
            IF (ISTAT .EQ. 1) NSTOM = NSTOM + 1
  100    CONTINUE
  110 CONTINUE
  120 REWIND 3
```

D-145

```
C
C     INPUT GEOMETRY DATA.
C
      DO 130 LP130 = 1,NOPL
         READ (8,170) SLOPE(LP130),SLGTH(LP130),RESIS(LP130),SLLG3(LP130
     1   )
  130 CONTINUE
C
C     PARAMETERS REQUIRED BY THE MODEL ARE GIVEN BELOW:
C
C     DZ = SPACE INCREMENT FOR THE SOIL TEMPERATURE CALCULATION
C          (METERS).
C     DLT = TIME INCREMENT FOR THE SOIL TEMPERATURE CALCULATION
C           (MINUTES).
C     TOTDP = TOTAL DEPTH OF SOIL (METERS).
C
      READ (95,180) DZ,DLT,TOTDP
C
C     R1 = DEOXYGENATION COEFFICIENT.
C     R3 = BOD REMOVAL CONSTANT BY SEDIMENT UPTAKE.
C     BA = RATE OF ADDITION OF BOD IN THE RUNOFF.
C
      READ (95,180) R1,R3,BA
C
C     THCO = THERMAL CONDUCTIVITY OF SOIL (CALORIES PER DAY PER METER
C            PER DEGREE CELSIUS).
C     SPGA = BULK DENSITY OF SOIL (GRAM PER CUBIC CENTIMETER).
C     SPHE = SPECIFIC HEAT OF SOIL (CALORIE PER GRAM PER DEGREE CELSIUS).
C
      READ (95,180) THCO,SPGA,SPHE
C
C     TRGRN = TRANSMISSIVITY OF GROUND COVER.
C     TRCAN = TRANMISSIVITY OF CANOPY.
C     ALT = AVERAGE HEIGHT OF WATERSHED ABOVE MEAN SEA LEVEL (METERS).
C
      DO 140 LP140 = 1,NOPL
         READ (95,180) TRGRN(LP140),TRCAN(LP140),ALT(LP140)
  140 CONTINUE
      RETURN
C
C     VARIOUS FORMATS.
C
  150 FORMAT (2I10)
  160 FORMAT (20X,22HERROR IN FILE RUNXXXX./20X,10HSTORM LOOP,1X,I10,1X,
     110HPLANE LOOP,1X,I10,1X,6HISTAT=,1X,I10,1X,16HNUMBER OF PLANES,1X,
     2I10///)
  170 FORMAT (4F12.5)
  180 FORMAT (3F10.3)
      END
```

SUBROUTINE TMCAL (M, N)

```
      SUBROUTINE TMCAL (M,N)
C
C     THIS PROGRAM UNIT IS USED TO EVALUATE THE THERMAL LOADING THROUGH
C     RUNOFF WATER.
C
      COMMON /ARAYS/        ALT(20)      , QL(200)      , RESIS(20)    ,
     1        SLGTH(20)    , SLLG3(20)    , SLOPE(20)    , TRCAN(20)    ,
     2        TRGRN(20)    , TSUM1(200)
      COMMON /BLOCK/        AREA         , BA           , CANCV        ,
     1        DLT          , DT           , DZ           , ELEN1        ,
     2        ELEN2        , ENG          , GRNCV        , IM           ,
     3        NOPL         , NSTOM        , R1           , R3           ,
```

```
     4        SPGA        , SPHE        , STE         , STIME       ,
     5        SUM1        , SUMD1       , SUMH1       , TA1         ,
     6        TA2         , TDEP        , TEM         , THCO        ,
     7        TOTDP       , U
C
C     PREPARE SOME PARAMETERS REQUIRED IN CALCULATING THE DAILY TOTALS
C     OF EXTRA-TERRESTRIAL RADIATION.
C
      AREA = SLGTH(N) * SLLG3(N)
C
C     CALCULATE THE TOTAL THERMAL LOADING ON THE SOIL BEFORE RAINFALL
C     START.
C
      QS = (ELEN1 + ELEN2)/2.0
      CATGR = CANCV * GRNCV
      ABGRN = 0.9 * (1.0 - CANCV - GRNCV + CATGR + TRCAN(N) * (CANCV - C
     1ATGR) + TRGRN(N) * (GRNCV - CATGR) + TRCAN(N) * TRGRN(N) * CATGR)
      ENG = QS * AREA * 10000.0 * ABGRN
C
C     CALCULATE THE TEMPERATURE DISTRIBUTION IN THE SOIL BEFORE RAIN-
C     FALL EVENT.
C
      CALL TMDIS
C
C     TEMPERATURE ROUTING ROUTINE IS CALLED.
C
      CALL COND (M,N)
C
C     CALCULATE TOTALS.
C
      SUM1 = 0.0
      SUMH1 = 0.0
      DO 100 LP100 = 1,IM
         SUM1 = QL(LP100) * 1000.0 * DT * SLLG3(N) * 60.0 + SUM1
         SUMH1 = QL(LP100) * TSUM1(LP100) * 1000.0 * DT * SLLG3(N) * 6.0
     1   E4 + SUMH1
  100 CONTINUE
C
C     CALCULATE TEMPERATURE LOADING.
C
      TEM = SUMH1/(SUM1 * 1000.0)
      RETURN
      END
```

SUBROUTINE TMDIS

```
      SUBROUTINE TMDIS
      COMMON /BLOCK/        AREA        , BA          , CANCV       ,
     1        DLT         , DT          , DZ          , ELEN1       ,
     2        ELEN2       , ENG         , GRNCV       , IM          ,
     3        NOPL        , NSTOM       , R1          , R3          ,
     4        SPGA        , SPHE        , STE         , STIME       ,
     5        SUM1        , SUMD1       , SUMH1       , TA1         ,
     6        TA2         , TDEP        , TEM         , THCO        ,
     7        TOTDP       , U
      DIMENSION             ST(100,30)
C
C     THIS PROGRAM UNIT IS USED TO CALCULATE THE AVERAGE TEMPERATURE
C     OF THE SURFACE SOIL LAYER.
C
      TS = TA1 - 3.0
      RA = ENG/STIME/60.0
      TOM = AREA * DZ * 1000000.0 * SPGA
      MS = IFIX (STIME/DLT * 60.0)
      NS = IFIX (TOTDP/DZ)
      BLPHA = THCO * 6.9444E - 10/SPHE/SPGA
      DO 100 LP100 = 1,NS
         ST(1,LP100) = TS + (10.0 - TS)/FLOAT (NS) * FLOAT (LP100)
  100 CONTINUE
      DO 120 LP120 = 1,MS
         ST(LP120 + 1,1) = ST(LP120,1) + RA * DLT/TOM/SPHE
         ST(LP120,NS + 1) = 10.0
         DO 110 LP110 = 2,NS
            ST(LP120 + 1,LP110) = BLPHA * ((ST(LP120,LP110 + 1) - 2.0 *
     1      ST(LP120,LP110) + ST(LP120,LP100 - 1))/DZ *  * 2.0) * DLT +
     2      ST(LP120,LP110)
  110    CONTINUE
         ST(LP120 + 1,1) = ST(LP120 + 1,1) - (ST(LP120 + 1,2) - ST(LP120
     1   ,2))
  120 CONTINUE
      MP = NS/2
      STE = (ST(MS + 1,1) + ST(MS + 1,MP))/2.0
      RETURN
      END
```

D-147

PROGRAM SBEROS

```
      PROGRAM SBEROS
     1(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE48=65,TAPE49=65,TAPE50=513,TAPE52=6
     25,TAPE53=65)
C
C     THIS PROGRAM SIMULATES THE STREAMBANK EROSION.
C
C     ******************************************************************
C     INPUT AND OUTPUT DICTIONARY.
C     ******************************************************************
C
C     INPUT FILES
C        READ (49,FM)  = BNKXXX
C        READ (52,FM)  = T52XXX
C
C     OUTPUT FILES
C        WRITE (6,FM)  = LINE PRINTER
C        WRITE (48,FM) = SBEXXX
C        WRITE (50)    = QPKXXX
C        WRITE (53,FM) = T53XXX
C
C     ******************************************************************
C
C     ******************************************************************
C     THIS PROGRAM CALCULATES THE AMOUNT OF STREAMBANK EROSION IN A
C     GIVEN STREAM CHANNEL, BASED ON THE HYDROLOGIC EXCITATION AND
C     THE MORPHOLOGIC CHARACTERISTICS OF THE CHANNEL REACH.
C
C                                                FORTRAN NAME   UNITS
C     INPUT DATA
C
C     HYDROLOGIC
C       EQUILIBRIUM WATER DISCHARGE                 QEQU       M**3/SEC
C       EQUILIBRIUM FLOW DEPTH                      DEQU       METERS
C       EQUILIBRIUM CHANNEL WIDTH                   WEQU       METERS
C       TRANSIENT WATER DISCHARGE                   QTRA       M**3/SEC
C       TRANSIENT FLOW DEPTH                        DTRA       METERS
C       TRANSIENT CHANNEL WIDTH                     WTRA       METERS
C     MORPHOLOGIC
C       A (IN WEQU=A*QEQU**B, AT-A-STATION)         ACON       NONE
C       B (IN WEQU=A*QEQU**B, AT-A-STATION)         BCON       NONE
C     GEOMETRIC
C       REACH LENGTH                                RLEN       KMETERS
C     SOIL CHARACTERISTICS
C       POROSITY OF BANK MATERIAL                   PORO       NONE
C       SPECIFIC GRAVITY OF BANK MATERIAL           SGRA       NONE
C       DIAMETER FOR WHICH 10 PERCENT IS FINER-BED  D10B       MM
C       DIAMETER FOR WHICH 16 PERCENT IS FINER-BANK D16K       MM
C       DIAMETER FOR WHICH 50 PERCENT IS FINER-BANK D50K       MM
C       DIAMETER FOR WHICH 84 PERCENT IS FINER-BANK D84K       MM
C     DISCHARGE
C       PEAK DISCHARGE OF STORM IN CHANNEL INDEX
C           AND SECTION JNDEX                       QPEAK      M**3/SEC
C       PEAK YEARLY DISCHARGE OF STORM IN
C           CHANNEL INDEX AND SECTION JNDEX         QPKYR      M**3/SEC
C       DISCHARGE CROSS SECTION AREA OF STORM PEAK
C           IN CHANNEL INDEX AND SECTION JNDEX      APEAK      M**2
C       DISCHARGE CROSS SECTION AREA OF YEARLY PEAK
C           IN CHANNEL INDEX AND SECTION JNDEX      APKYR      M**2
C       NUMBER OF CHANNELS                          NSEG       NONE
C       NUMBER OF SECTIONS                          NDX        NONE
C
C     OUTPUT DATA
C
C     EROSION
C       TOTAL AMOUNT OF BANK EROSION                TABE       MET TONS
C       SUSPENDED AMOUNT OF BANK EROSION            SABE       MET TONS
C       YEARLY TOTAL AMOUNT OF BANK EROSION         T          MET TONS
C       YEARLY TOTAL SUSPENDED AMOUNT OF BANK
```

D-143

```
C          EROSION                                  S          MET TONS
C     ****************************************************************
C
      DIMENSION            APEAK(10,5) , APKYR(10,5) , QPEAK(10,5) ,
     1        QPKYR(10,5)
C
C     CHECK FOR BAD POSITION ON FILE T52XXX.
C
      NEOF = 1
      READ (52,101) IDUM
      IF (EOF(52) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (6,111)
      IF (NEOF .EQ. 0) CALL EXIT
C
C     INITIALIZE VARIABLES.
C
      NSEG = 0
      NDX = 0
      T = 0.0
      S = 0.0
      DO 21 LP21 = 1,5
         DO 11 LP11 = 1,10
            APKYR(LP11,LP21) = 0.0
            QPKYR(LP11,LP21) = 0.0
   11    CONTINUE
   21 CONTINUE
C
C     CALCULATE YEARLY PEAK VALUES.
C
   31 READ (50) INDEX,JNDEX,QPEAK(INDEX,JNDEX),APEAK(INDEX,JNDEX)
      IF (EOF(50) .NE. 0.0) GO TO 41
      IF (JNDEX .GT. NDX) NDX = JNDEX
      IF (INDEX .GT. NSEG) NSEG = INDEX
      IF (QPEAK(INDEX,JNDEX) .GT. QPKYR(INDEX,JNDEX)) APKYR(INDEX,JNDEX)
     1 = APEAK(INDEX,JNDEX)
      IF (QPEAK(INDEX,JNDEX) .GT. QPKYR(INDEX,JNDEX)) QPKYR(INDEX,JNDEX)
     1 = QPEAK(INDEX,JNDEX)
      GO TO 31
C
C     COMPUTE SOIL BANK EROSION FOR ALL CHANNEL SEGMENTS.
C
   41 GAM = 1000.0
      READ (49,121) SGRA
      DO 91 LP91 = 1,NSEG
         READ (49,121) PORO,D10B,D16K,D50K,D84K
         DO 81 LP81 = 1,NDX
            READ (49,131) ACON,BCON,RLEN
            READ (52,131) QEQU,DEQU,WEQU
            QTRA = QPKYR(LP91,LP81)
            IF (QTRA .EQ. 0.0) GO TO 51
            WTRA = ACON * (QTRA *  * BCON)
            DTRA = APKYR(LP91,LP81)/WTRA
            RLENU = RLEN * 1000.0
            A1 = ACON *  * (1.0/(1.0 - BCON))
            B1 = BCON/(1.0 - BCON)
            A2 = A1 * B1
            B2 = B1 - 1.0
            QU = QEQU/WEQU
            DELQU = QTRA/WTRA - QU
            IF (DELQU .GT. 0.0) GO TO 61
   51       TABE = 0.0
            SABE = 0.0
            GO TO 71
   61       DW = A2 * DELQU * QU *  * B2
            DAVE = 0.5 * (DEQU + DTRA)
            TABEU = DW * RLENU * DAVE * (1.0 - PORO) * SGRA * GAM
            TABE = TABEU/1000.0
            IF (D10B .LE. D50K) N = 1
            IF (D10B .GT. D50K) N = 2
            IF (N .EQ. 1) DREK = D16K
```

D-144

```
      IF (N .EQ. 2) DREK = D84K
      PS = (50.0 + ( - 1.0) *  * N * 34.0 * (D10B - D50K)/(DREK -
     1 D50K))/100.0
      SABE = PS * TABE
   71 WRITE (6,141) LP91,LP81
      WRITE (6,151) TABE,SABE
      WRITE (6,161) QPKYR(LP91,LP81),APKYR(LP91,LP81)
      AEQU = WEQU * DEQU
      WRITE (6,171) QEQU,AEQU
      WRITE (53,131) QEQU,DEQU,WEQU
      T = T + TABE * 1000.0
      S = S + SABE * 1000.0
   81 CONTINUE
   91 CONTINUE
C
C     OUTPUT YEARLY TOTALS.
C
      WRITE (48,181) T
      WRITE (48,181) S
C
C     OUTPUT END-OF-SUBFILE MARK FOR FILE T53XXX.
C
      END FILE 53
C
C     TERMINATE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
  101 FORMAT (A2)
  111 FORMAT (/20X,51HFILE STRUCTURE ERROR ON T52XXX, MESSAGE FROM SWERO
     1.,/)
  121 FORMAT (5F10.7)
  131 FORMAT (3F15.5)
  141 FORMAT (//,20X,22HTHE CHANNEL NUMBER IS ,I3/,20X,22HTHE SECTION NU
     1MBER IS ,I3//)
  151 FORMAT (//,20X,29HTOTAL AMOUNT OF BANK EROSION=,6X,E15.6,/,20X,33H
     1SUSPENDED AMOUNT OF BANK EROSION=,2X,E15.6//)
  161 FORMAT (20X,9HQPKYEAR= ,E19.10,2X,9HAPKYEAR= ,E19.10)
  171 FORMAT (20X,6HQEQU= ,3X,E19.10,2X,6HAEQU= ,3X,E19.10)
  181 FORMAT (2X,G30.10)
      END
```

D-145

PROGRAM RILL

```
      BLOCK DATA
C
C     DECLARATION OF COMMON BLOCKS IN THE PROGRAM RILL.
C
      COMMON /ARAYS/        RA(50)
      COMMON /BLOCK/        IB
      END
      PROGRAM RILL
     1(INPUT,OUTPUT,TAPE4=65,TAPE5=65,TAPE6=OUTPUT,TAPE7=513,TAPE8=513,T
     2APE51=65,TAPE52=65,TAPE53=65)
C
C     THIS PROGRAM SIMULATES THE LITTER MODEL.
C
C     ****************************************************************
C     INPUT AND OUTPUT DICTIONARY.
C     ****************************************************************
C
C     INPUT FILES
C        READ (5,FM)   = INLXXX
C        READ (7)      = NGEXXX
C        READ (8)      = EX1XXX
C        READ (51,FM)  = MANXXX
C        READ (52,FM)  = T52XXX
C
C     OUTPUT FILES
C        WRITE (4,FM)  = LITXXX
C        WRITE (6,FM)  = LINE PRINTER
C        WRITE (53,FM) = T53XXX
C
C     ****************************************************************
C
C     ****************************************************************
C     **** THIS PROGRAM CALCULATES RILL DENSITY IN LAMINAR OR TURBULENT
C     **** IT ALSO CALCULATES QUANTITY OF  FOREST LITTER LOADING FOR IND
C     **** RAINFALL EVENTS.
C
C     MODE = 0     RILL DENSITY IN LAMINAR FLOW
C     MODE = 1     RILL DENSITY IN TURBULENT FLOW
C     **** INPUT DATA                                  FORTRAN NAME
C     GEOMETRIC
C       NUMBER OF PLANES                                 NPL
C       LENGTH OF PLANE                                  XLEN
C       WIDTH OF PLANE                                   WIDT
C       SLOPE OF PLANE                                   SLOP
C     HYDROLOGIC
C       PRECIPITATION                                    PREC
C     HYDRAULIC
C       DARCY-WEISBACH F (TURBULENT FLOW)                FDAR
C       K1 (IN F = K1/REYNOLOS NUMBER)                   XK1C
C       K2 (CONSTANT IN SHIELDS' CRITERIA)               XK2C
C       A  (IN P = A*AREA**0.5)                          ACON
C     SOIL
C       DIAMETER FOR WHICH 84 PERCENT IS FINER           D84F
C       ANGLE OF FRICTION (IF UNKNOWN, ENTER ANGL = 0)   ANGL
C     VEGETATIVE
C       FOREST LITTER ON GROUND                          FLIT
C       FOREST LITTER PRODUCTION RATE                    FLITR
C       MAX. AVERAGE RILL DENSITY DEVELOPED
C       OVER THE AREA                                    PKRIL
C     **** OUTPUT RESULTS
C       FOREST LITTER LOADING                            FLOD
C       TOTAL LITTER LOADING FOR ALL PLANES              TFLOD
C     ****************************************************************
C
      COMMON /ARAYS/        PREC(50)
      COMMON /BLOCK/        NPL
C
C     CHECK FOR BAD POSITION ON FILE MANXXX.
```

```
C
      NEOF = 1
      READ (51,61) IDUM
      IF (EOF(51) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (6,71)
      IF (NEOF .EQ. 0) CALL EXIT
C
C     CHECK FOR BAD POSITION ON FILE T52XXX.
C
      READ (52,61) IDUM
      IF (EOF(52) .EQ. 0.0) NEOF = 0
      IF (NEOF .EQ. 0) WRITE (6,81)
      IF (NEOF .EQ. 0) CALL EXIT
C
C     INITIALIZE VARIABLES.
C
      TFLOD = 0.0
      GRAV = 32.17
      VISC = 0.00001
C
C     INPUT NUMBER OF PLANES.
C
      READ (5,91) NPL
C
C     ACCESS ADDITIONAL INPUT INFORMATION.
C
      CALL INPT
      DO 51 LP51 = 1,NPL
         READ (7) XLEN,WIDT,SLOP,IDUM1,IDUM2,IDUM3,DUR
         READ (5,101) MODE
         READ (5,111) ACON,D84F,ANGL,PEAKE
         READ (52,111) FLIT
         READ (51,111) FLITR
         READ (5,111) ENTRY
         IF (MODE .EQ. 0) XK1C = ENTRY
         IF (MODE .EQ. 1) FDAR = ENTRY
         PEAKE = PEAKE/43200.0
         PRECU = PREC(LP51)/43200.0
         IF (PRECU .LT. 0.00000001) GO TO 31
         D84FU = D84F/304.8
         IF (ANGL .EQ. 0.0) ANGL = 25.0
         XK2C = 0.08
         CA = 0.61 * ANGL *  * 0.021
         CT = 210.0 * ANGL *  * ( - 1.038)
         IF (MODE .EQ. 1) GO TO 11
         CLAM = XK1C * ACON *  * 2/(CA *  * 2 * CT * XK2C *  * 3)
         PKRIL = 0.5 * CLAM * (VISC/(8.0 * GRAV * D84FU *  * 3)) * (PEAK
     1   E * XLEN * SLOP *  * 2)
         RILD = 100.0 * CLAM * (VISC/(8.0 * GRAV * D84FU *  * 3)) * (PRE
     1   CU * XLEN * SLOP *  * 2)
         GO TO 21
   11    CTUR = SQRT(FDAR * ACON)/(CA *  * 1.25 * CT *  * 0.25 * XK2C *
     1   * 1.5)
         PKRIL = 0.5 * CTUR/SQRT(8.0 * GRAV * D84FU *  * 3) * (PEAKE * X
     1   LEN * SLOP)
         RILD = 100.0 * CTUR/SQRT(8.0 * GRAV * D84FU *  * 3) * (PRECU *
     1   XLEN * SLOP)
   21    IF (RILD .GT. 100.0) RILD = 100.0
         RILAV = 0.5 * (RILD/100.0)
         RATIO = (PRECU/PEAKE) *  * 0.24
         IF (RILAV .GT. PKRIL) RATIO = 1.0
         IF (RILAV .GT. PKRIL) PKRIL = RILAV
         AREA = WIDT * XLEN
         FLIT = FLIT + (DUR/365.0) * FLITR
         FLOD = RILAV * AREA * FLIT * RATIO
         GO TO 41
   31    FLOD = 0.0
   41    FLIT = FLIT - FLOD/AREA
         WRITE (53,111) FLIT
         TFLOD = TFLOD + FLOD
```

D-147

```
      PEAK = PKRIL/2.54
      WRITE (6,121) RATIO,RILAV,PKRIL,PEAKE,PRECU
      WRITE (6,131) FLOD,PEAK
   51 CONTINUE
      WRITE (4,141) TFLOD
C
C     OUTPUT END-OF-SUBFILE MARK FOR FILE T53XXX.
C
      END FILE 53
C
C     TERMINATE THE PROGRAM NORMALLY.
C
      STOP
C
C     VARIOUS FORMATS.
C
   61 FORMAT (A2)
   71 FORMAT (/20X,50HFILE STRUCTURE ERROR ON MANXXX, MESSAGE FROM RILL.
     1,/)
   81 FORMAT (/20X,50HFILE STRUCTURE ERROR ON T52XXX, MESSAGE FROM RILL.
     1,/)
   91 FORMAT (I10)
  101 FORMAT (I1)
  111 FORMAT (4F10.0)
  121 FORMAT (/20X,9HTRATIO = ,F12.5,2X,8HRILAV = ,F12.5,2X,10HPEAKRIL =
     1 ,F12.5,/20X,9HPEAKEX = ,F12.5,2X,8HPRECU = ,F12.5/)
  131 FORMAT (20X,7HFLOD = ,2X,F12.2,2X,7HPEAK = ,1X,F12.5)
  141 FORMAT (2X,G30.10)
      END
```

SUBROUTINE INPT

```
      SUBROUTINE INPT
C
C     THIS PROGRAM UNIT READS THE EXCESS RAINFALL FROM THE FILE EX1XXX.
C     IT THEN SEARCHES EACH WATERSHED FOR THE PEAK RAINFALL AND THIS
C     PEAK IS THEN USED AS THE EVENT FOR THE YEAR.
C
      COMMON /ARAYS/        PREC(50)
      COMMON /BLOCK/        NPL
      COMMON /TAPES/        IA(16)      , IDC4(144)   , IDC7(144)   ,
     1        IDC8(144)   , IDC53(144)  , IERR(4)     , INOUT(828)
      DIMENSION             RIO(414)
      EQUIVALENCE           (INOUT(1)   , RIO(1))
      DO 100 LP100 = 1,50
         PREC(LP100) = 0.0
  100 CONTINUE
      IPLMX = 0
  110 CALL READF (IDC8,IERR(3),INOUT,828,LEN)
      IF (LEN .EQ. - 1) GO TO 140
      IPLNE = INOUT(1)
      IF (IPLNE .GT. IPLMX) IPLMX = IPLNE
      K = INOUT(10)
      DO 130 LP130 = 1,K
         JJ130 = (LP130 - 1) * 2 + 11
         RIO(JJ130) = RIO(JJ130)/2.54
         IF (RIO(JJ130) .GT. PREC(IPLNE)) PREC(IPLNE) = RIO(JJ130)
  130 CONTINUE
      GO TO 110
  140 IF (NPL .NE. IPLMX) WRITE (6,150) IPLMX,NPL
      IF (NPL .NE. IPLMX) CALL EXEC (6,0,3)
      RETURN
  150 FORMAT (/20X,30HDATA CONFLICT IN PROGRAM RILL.,/20X,32HNUMBER OF P
     1LANES ON FILE EX1XXX=,I10,/20X,32HNUMBER OF PLANES ON FILE INLXXX=
     2,I10)
      END
```

D-143

PROGRAM GOALSUM

```
      PROGRAM GOALSUM
     1(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE42=65,TAPE43=65,TAPE44=65,TAPE45=65
     2,TAPE46=65,TAPE47=65,TAPE48=65)
C
C     THIS PROGRAM SUMMARIZES THE MANAGEMENT RESULTS.
C
C     ################################################################
C     INPUT AND OUTPUT DICTIONARY.
C     ################################################################
C
C     INPUT FILES
C        READ (42,FM)  = T42XXX = GOAXXX
C        READ (43,FM)  = LITXXX
C        READ (44,FM)  = NUTXXX
C        READ (45,FM)  = OXTXXX
C        READ (46,FM)  = WSMXXX
C        READ (47,FM)  = SBEXXX
C        READ (48,FM)  = SSMXXX
C
C     OUTPUT FILES
C        WRITE (6,FM)  = LINE PRINTER
C        WRITE (42,FM) = T52XXX = GOAXXX
C
C     ################################################################
C
      DIMENSION            ALLIO(7)    , PTOTS(7)
C
C     INPUT PREVIOUS TOTALS AND REWIND FILE.
C
      DO 11 LP11 = 1,7
         READ (42,31) PTOTS(LP11)
   11 CONTINUE
      REWIND 42
C
C     OUTPUT PREVIOUS TOTALS.
C
      WRITE (6,41) (PTOTS(IMPD1),IMPD1 = 1,7)
C
C     INPUT TOTAL SEDIMENT YIELD.
C
      READ (48,51) SSM
C
C     INPUT SOIL BANK EROSION.
C
      READ (47,51) SBE
C
C     CALCULATE SEDIMENT YIELD.
C
      ALLIO(2) = SSM + SBE
C
C     INPUT TOTAL WATER YIELD.
C
      READ (46,51) ALLIO(1)
C
C     INPUT TOTAL OXYGEN AND TEMPERATURE LOADING.
C
      READ (45,51) ALLIO(3)
      READ (45,51) ALLIO(4)
C
C     INPUT TOTAL NUTRIENT PRODUCTION:  NITROGEN AND PHOSPHORUS.
C
      READ (44,51) ALLIO(5)
      READ (44,51) ALLIO(6)
C
C     INPUT TOTAL LITTER PRODUCTION.
C
      READ (43,51) ALLIO(7)
C
```

APPENDIX E

SAMPLE OUTPUT FOR PROGRAMS FOR UNDISTURBED RESPONSE

```
T
                 17.63991   22.90825   39.46613   39.47277   39.42913
                 17.63877   22.90806   39.46598   39.47269   39.42908
                 17.63991   22.90825   39.46613   39.47277   39.42913
                 17.64108   22.90845   39.46628   39.47286   39.42920
1      7 C   D I R E C T I V E S                    SORT/MERGE 4.6 L508  81/11/13. 08.52.35.      PAGE    1

     1  SORT.
     2  FILE,INPUT=TAPE1,OUTPUT=TAPE2.
     3  FIELD,STORM(.61,.60,INTEGER),STATION(.1,.60,INTEGER)
     4  KEY,STORM(A),STATION(A)
     5  END
1      7 C   D I R E C T I V E S                    SORT/MERGE 4.6 L508  81/11/13. 08.52.48.      PAGE    1

     1  SORT.
     2  FILE,INPUT=TAPE1,OUTPUT=TAPE2.
     3  FIELD,STORM(.61,.60,INTEGER),STATION(.1,.60,INTEGER)
     4  KEY,STORM(A),STATION(A)
     5  END
1      7 C   D I R E C T I V E S                    SORT/MERGE 4.6 L508  81/11/13. 08.52.52.      PAGE    1

     1  SORT.
     2  FILE,INPUT=TAPE1,OUTPUT=TAPE2.
     3  FIELD,STORM(.61,.60,INTEGER),STATION(.1,.60,INTEGER)
     4  KEY,STORM(A),STATION(A)
     5  END
1      7 C   D I R E C T I V E S                    SORT/MERGE 4.6 L508  81/11/13. 08.52.56.      PAGE    1

     1  SORT.
     2  FILE,INPUT=TAPE1,OUTPUT=TAPE2.
     3  FIELD,STORM(.61,.60,INTEGER),STATION(.1,.60,INTEGER)
     4  KEY,STORM(A),STATION(A)
     5  END
```

```
LOOP INDEX E STATION EXC STORM EX RUNOFF INTEG EXC
        1        1        1     .7527     .7527

LOOP INDEX E STATION EXC STORM EX RUNOFF INTEG EXC
        2        2        1     .7527     .7527

LOOP INDEX E STATION EXC STORM EX RUNOFF INTEG EXC
        3        3        1     .7527     .7527

LOOP INDEX E STATION EXC STORM EX RUNOFF INTEG EXC
        4        4        1     .7527     .7527

LOOP INDEX E STATION EXC STORM EX RUNOFF  RUN STAT RUN STORM RU RUNOFF  RAI STAT RAI STORM TEM DEG C
        1        1        1     .7527        1        1     .7527        1        1   16.2000

LOOP INDEX E STATION EXC STORM EX RUNOFF  RUN STAT RUN STORM RU RUNOFF  RAI STAT RAI STORM TEM DEG C
        2        2        1     .7527        2        1     .7527        2        1   16.2000

LOOP INDEX E STATION EXC STORM EX RUNOFF  RUN STAT RUN STORM RU RUNOFF  RAI STAT RAI STORM TEM DEG C
        3        3        1     .7527        3        1     .7527        3        1   16.2000

LOOP INDEX E STATION EXC STORM EX RUNOFF  RUN STAT RUN STORM RU RUNOFF  RAI STAT RAI STORM TEM DEG C
        4        4        1     .7527        4        1     .7527        4        1   16.2000

ISTOR=   1   1   1  INDEX= 0  CHECK=  .7527E+00
```

```
THIS IS THE USER PROGRAM FOR THE MULTI-WATERSHED MODEL.

ENTER YOUR RESPONSES ONLY AFTER THE READY SIGNAL IS GIVEN.


DO YOU WISH TO ACCESS THE MODEL BY
      1.  CALENDAR DATE
      2.  THE EVENT NUMBER OF THE STORM
      3.  VOLUME OF THE STORM
      4.  ROUTE EVERY EVENT

ENTER THE NUMBER;I.E.,1,2,3,OR 4; OF YOUR CHOICE.


READY,ENTER RESPONSE.


YOU HAVE CHOSEN TO ROUTE EVERY EVENT.  YOU WILL
RECEIVE THE EVENT NUMBER, THE CALENDAR DATE, AND
VOLUME OF THE STORM.  THEN YOU WILL RECEIVE THE
RESULTS.


CALENDAR DAY          EVENT NUMBER    STORM VOLUME(CM)
  52872                        3            7.58108

ENTER BEGINNING TIME AND FINAL TIME TO RUNOFF (IN MINUTES.)
ENTER ONE LINE FOR EACH PLANE.  THERE ARE   4 PLANES.
THE RESULTS FOR UNIT NUMBER:                        1
THE TOTAL AREA IN HECTARES:                 .60703E+02
THE TOTAL RAINFALL IN CUBIC METERS:         .59732E+05
THE TOTAL DISCHARGE IN CUBIC METERS:        .44872E+05
THE TOTAL SEDIMENT YIELD IN KILOGRAMS:      .20059E+06


(NOTE:  THE FOLLOWING VALUES ARE PER METER WIDTH, IF THE UNIT IS A PL

THE SEDIMENT YIELD BY SIZES
SIZE IN MM          KILOGRAMS
  .70711E-02       .37983E+05
  .31623E-01       .80714E+05
  .31623E+00       .80714E+05
  .14142E+01       .11780E+04
  .34641E+01      0.
  .10954E+02      0.
  .24495E+02      0.


FINAL HYDROGRAPH

        TIME        DISCHARGE
      (MIN.)          (CMS)
        9.00       .20445E+01
       18.00       .47022E+01
       27.00       .31949E+01
       36.00       .45616E+01
       45.00       .98320E+01
       54.00       .75179E+01
       63.00       .34876E+01
       72.00       .45343E+01
       81.00       .33518E+01
       90.00       .76375E+00
       99.00       .25413E+00
      108.00       .13859E+00
      117.00       .90608E-01
      126.00       .65221E-01
      135.00       .49857E-01
```

144.00	.39719E-01
153.00	.32613E-01
162.00	.27404E-01
171.00	.23475E-01
180.00	.20425E-01
189.00	.17984E-01
198.00	.34734E-01
207.00	.78109E-01
216.00	.94062E-01
225.00	.77247E-01
234.00	.64176E-01
243.00	.53865E-01
252.00	.45626E-01
261.00	.38965E-01
270.00	.33524E-01
279.00	.29037E-01
288.00	.25309E-01
297.00	.22213E-01
306.00	.19600E-01
315.00	.17378E-01
324.00	.15508E-01
333.00	.13940E-01
342.00	.12619E-01
351.00	.11494E-01
360.00	.10525E-01
369.00	.96851E-02
378.00	.89507E-02
387.00	.83042E-02
396.00	.77321E-02
405.00	.72233E-02
414.00	.67666E-02
423.00	.63559E-02
432.00	.59849E-02
441.00	.56486E-02
450.00	.53426E-02
459.00	.50631E-02
468.00	.48072E-02
477.00	.45720E-02
486.00	.43554E-02
495.00	.41553E-02
504.00	.39700E-02
513.00	.37981E-02
522.00	.36382E-02
531.00	.34892E-02
540.00	.33503E-02
549.00	.32199E-02
558.00	.30980E-02
567.00	.29835E-02
576.00	.28759E-02
585.00	.27746E-02
594.00	.26791E-02
603.00	.25890E-02
612.00	.25038E-02
621.00	.24231E-02
630.00	.23467E-02
639.00	.22742E-02
648.00	.22053E-02
657.00	.21399E-02
666.00	.20776E-02
675.00	.20183E-02
684.00	.19617E-02
693.00	.19077E-02
702.00	.18562E-02
711.00	.18069E-02
720.00	.17598E-02
729.00	.17146E-02
738.00	.16714E-02
747.00	.16301E-02
756.00	.15904E-02
765.00	.15522E-02
774.00	.15155E-02
783.00	.14803E-02

E-4

792.00	.14464E-02
801.00	.64002E-01
810.00	.11984E+00
819.00	.10653E+00
828.00	.93364E-01
837.00	.79666E-01
846.00	.50650E+01
855.00	.55053E+01
864.00	.62934E+00
873.00	.23287E+00
882.00	.13092E+00
891.00	.86846E-01
900.00	.32764E+01
909.00	.49337E+01
918.00	.29880E+01
927.00	.15395E+01
936.00	.33827E+01
945.00	.39322E+01
954.00	.10002E+01
963.00	.30584E+00
972.00	.16060E+00
981.00	.10262E+00
990.00	.72701E-01
999.00	.26765E+00
1008.00	.37626E+00
1017.00	.22541E+00
1026.00	.14084E+00
1035.00	.93179E-01
1044.00	.82837E-01
1053.00	.11207E+00
1062.00	.15946E+00
1071.00	.20785E+00
1080.00	.25169E+00
1089.00	.28212E+00
1098.00	.29271E+00
1107.00	.25707E+00
1116.00	.18219E+00
1125.00	.12133E+00
1134.00	.86505E-01
1143.00	.64992E-01
1152.00	.50831E-01
1161.00	.41019E-01
1170.00	.33925E-01
1179.00	.28622E-01
1188.00	.24556E-01
1197.00	.21384E-01
1206.00	.18833E-01
1215.00	.16745E-01
1224.00	.15011E-01
1233.00	.13553E-01
1242.00	.12313E-01
1251.00	.11248E-01
1260.00	.10327E-01
1269.00	.95239E-02
1278.00	.88183E-02
1287.00	.81949E-02
1296.00	.76408E-02
1305.00	.71465E-02
1314.00	.67022E-02
1323.00	.63016E-02
1332.00	.59391E-02
1341.00	.56098E-02
1350.00	.53096E-02
1359.00	.50351E-02
1368.00	.47833E-02
1377.00	.45517E-02
1386.00	.43380E-02
1395.00	.41405E-02
1404.00	.39574E-02
1413.00	.37873E-02
1422.00	.36291E-02
1431.00	.34814E-02
1440.00	.33435E-02
1449.00	.32144E-02

1458.00	.30934E-02
1467.00	.29797E-02
1476.00	.28728E-02
1485.00	.27721E-02
1494.00	.26772E-02
1503.00	.25875E-02
1512.00	.25026E-02
1521.00	.24223E-02
1530.00	.23462E-02
1539.00	.22740E-02
1548.00	.22054E-02
1557.00	.21402E-02
1566.00	.20780E-02
1575.00	.20189E-02
1584.00	.19625E-02
1593.00	.19086E-02
1602.00	.18572E-02
1611.00	.15391E-02
1620.00	.11049E-02
1629.00	.92241E-03
1638.00	.89918E-03
1647.00	.87690E-03
1656.00	.85552E-03
1665.00	.59477E-03
1674.00	0.

THE RESULTS FOR UNIT NUMBER: 2
THE TOTAL AREA IN HECTARES: .31959E+02
THE TOTAL RAINFALL IN CUBIC METERS: .31447E+05
THE TOTAL DISCHARGE IN CUBIC METERS: .24133E+05
THE TOTAL SEDIMENT YIELD IN KILOGRAMS: .10568E+06

(NOTE: THE FOLLOWING VALUES ARE PER METER WIDTH, IF THE UNIT IS A PLANE

THE SEDIMENT YIELD BY SIZES

SIZE IN MM	KILOGRAMS
.70711E-02	.15260E+01
.31623E-01	.32427E+01
.31623E+00	.32427E+01
.14142E+01	.41525E-01
.34641E+01	0.
.10954E+02	0.
.24495E+02	0.

FINAL HYDROGRAPH

TIME (MIN.)	DISCHARGE (CMS)
9.00	.53009E-03
18.00	.73171E-03
27.00	.12724E-03
36.00	.11232E-02
45.00	.15288E-02
54.00	.44043E-03
63.00	.46779E-03
72.00	.73779E-03

E-9

81.00	.13693E-03
90.00	.38302E-04
99.00	.19281E-04
108.00	.12043E-04
117.00	.84167E-05
126.00	.63030E-05
135.00	.49459E-05
144.00	.40141E-05
153.00	.33420E-05
162.00	.28384E-05
171.00	.24497E-05
180.00	.21422E-05
189.00	.18941E-05
198.00	.70186E-05
207.00	.14660E-04
216.00	.11735E-04
225.00	.95028E-05
234.00	.77727E-05
243.00	.64138E-05
252.00	.53338E-05
261.00	.44661E-05
270.00	.37623E-05
279.00	.31864E-05
288.00	.27214E-05
297.00	.23586E-05
306.00	.20697E-05
315.00	.18353E-05
324.00	.16420E-05
333.00	.14803E-05
342.00	.13435E-05
351.00	.12265E-05
360.00	.11257E-05
369.00	.10378E-05
378.00	.96083E-06
387.00	.89289E-06
396.00	.83259E-06
405.00	.77879E-06
414.00	.73054E-06
423.00	.68707E-06
432.00	.64774E-06
441.00	.61203E-06
450.00	.57948E-06
459.00	.54972E-06
468.00	.52242E-06
477.00	.49731E-06
486.00	.47414E-06
495.00	.45272E-06
504.00	.43286E-06
513.00	.41442E-06
522.00	.39724E-06
531.00	.38123E-06
540.00	.36625E-06
549.00	.35224E-06
558.00	.33909E-06
567.00	.32675E-06
576.00	.31513E-06
585.00	.30419E-06
594.00	.29386E-06
603.00	.28411E-06
612.00	.27488E-06
621.00	.26614E-06
630.00	.25786E-06
639.00	.25000E-06
648.00	.24252E-06
657.00	.23542E-06
666.00	.22865E-06
675.00	.22220E-06
684.00	.21605E-06
693.00	.21018E-06
702.00	.20457E-06
711.00	.19920E-06
720.00	.19406E-06
729.00	.18915E-06

738.00	.18443E-06
747.00	.17991E-06
756.00	.17557E-06
765.00	.17140E-06
774.00	.16740E-06
783.00	.16354E-06
792.00	.15984E-06
801.00	.20431E-04
810.00	.17863E-04
819.00	.15211E-04
828.00	.11984E-04
837.00	.84271E-05
846.00	.13238E-02
855.00	.10955E-03
864.00	.34679E-04
873.00	.18099E-04
882.00	.11498E-04
891.00	.81158E-05
900.00	.10384E-02
909.00	.41003E-03
918.00	.32781E-03
927.00	.56186E-04
936.00	.96231E-03
945.00	.19296E-03
954.00	.48276E-04
963.00	.23088E-04
972.00	.13982E-04
981.00	.95666E-05
990.00	.70520E-05
999.00	.67431E-04
1008.00	.36533E-04
1017.00	.20090E-04
1026.00	.12438E-04
1035.00	.86436E-05
1044.00	.10788E-04
1053.00	.17646E-04
1062.00	.25130E-04
1071.00	.32247E-04
1080.00	.37484E-04
1089.00	.38543E-04
1098.00	.38543E-04
1107.00	.28300E-04
1116.00	.17626E-04
1125.00	.11980E-04
1134.00	.86950E-05
1143.00	.66287E-05
1152.00	.52459E-05
1161.00	.42729E-05
1170.00	.35614E-05
1179.00	.30240E-05
1188.00	.26072E-05
1197.00	.22766E-05
1206.00	.20096E-05
1215.00	.17904E-05
1224.00	.16078E-05
1233.00	.14541E-05
1242.00	.13231E-05
1251.00	.12105E-05
1260.00	.11129E-05
1269.00	.10277E-05
1278.00	.95273E-06
1287.00	.88640E-06
1296.00	.82738E-06
1305.00	.77459E-06
1314.00	.72716E-06
1323.00	.68436E-06
1332.00	.64557E-06
1341.00	.61031E-06
1350.00	.57812E-06
1359.00	.54866E-06

E-1D

1368.00	.52161E-06
1377.00	.49670E-06
1386.00	.47371E-06
1395.00	.45243E-06
1404.00	.43269E-06
1413.00	.41434E-06
1422.00	.39725E-06
1431.00	.38130E-06
1440.00	.36639E-06
1449.00	.35242E-06
1458.00	.33932E-06
1467.00	.32700E-06
1476.00	.31541E-06
1485.00	.30449E-06
1494.00	.29419E-06
1503.00	.28445E-06
1512.00	.27523E-06
1521.00	0.
1530.00	0.
1539.00	0.
1548.00	0.
1557.00	0.
1566.00	0.
1575.00	0.
1584.00	0.
1593.00	0.
1602.00	0.
1611.00	0.
1620.00	0.
1629.00	0.
1638.00	0.
1647.00	0.
1656.00	0.
1665.00	0.
1674.00	0.

THE RESULTS FOR UNIT NUMBER: 3
THE TOTAL AREA IN HECTARES: .30974E+02
THE TOTAL RAINFALL IN CUBIC METERS: .30478E+05
THE TOTAL DISCHARGE IN CUBIC METERS: .23731E+05
THE TOTAL SEDIMENT YIELD IN KILOGRAMS: .10353E+06

(NOTE: THE FOLLOWING VALUES ARE PER METER WIDTH, IF THE UNIT IS A PLANE

THE SEDIMENT YIELD BY SIZES

SIZE IN MM	KILOGRAMS
.70711E-02	.14822E+01
.31623E-01	.31496E+01
.31623E+00	.31496E+01
.14142E+01	.10776E+00
.34641E+01	0.
.10954E+02	0.
.24495E+02	0.

FINAL HYDROGRAPH

TIME (MIN.)	DISCHARGE (CMS)
9.00	.51052E-03
18.00	.72746E-03
27.00	.11659E-03
36.00	.11255E-02
45.00	.14817E-02
54.00	.42176E-03
63.00	.45239E-03
72.00	.71904E-03
81.00	.12344E-03

E-11

90.00	.34283E-04
99.00	.17233E-04
108.00	.10758E-04
117.00	.75167E-05
126.00	.56281E-05
135.00	.44159E-05
144.00	.35837E-05
153.00	.29835E-05
162.00	.25338E-05
171.00	.21868E-05
180.00	.19122E-05
189.00	.16907E-05
198.00	.68941E-05
207.00	.14856E-04
216.00	.11742E-04
225.00	.93788E-05
234.00	.75586E-05
243.00	.61377E-05
252.00	.50154E-05
261.00	.41194E-05
270.00	.33981E-05
279.00	.28476E-05
288.00	.24309E-05
297.00	.21066E-05
306.00	.18484E-05
315.00	.16389E-05
324.00	.14662E-05
333.00	.13218E-05
342.00	.11997E-05
351.00	.10952E-05
360.00	.10050E-05
369.00	.92652E-06
378.00	.85776E-06
387.00	.79710E-06
396.00	.74326E-06
405.00	.69522E-06
414.00	.65214E-06
423.00	.61333E-06
432.00	.57822E-06
441.00	.54634E-06
450.00	.51728E-06
459.00	.49071E-06
468.00	.46633E-06
477.00	.44391E-06
486.00	.42323E-06
495.00	.40411E-06
504.00	.38638E-06
513.00	.36991E-06
522.00	.35458E-06
531.00	.34028E-06
540.00	.32692E-06
549.00	.31441E-06
558.00	.30267E-06
567.00	.29165E-06
576.00	.28128E-06
585.00	.27151E-06
594.00	.26229E-06
603.00	.25359E-06
612.00	.24535E-06
621.00	.23755E-06
630.00	.23016E-06
639.00	.22314E-06
648.00	.21647E-06
657.00	.21012E-06
666.00	.20408E-06
675.00	.19833E-06
684.00	.19283E-06
693.00	.18759E-06
702.00	.18258E-06
711.00	.17779E-06

E-12

720.00	.17321E-06
729.00	.16882E-06
738.00	.16461E-06
747.00	.16057E-06
756.00	.15670E-06
765.00	.15298E-06
774.00	.14940E-06
783.00	.14597E-06
792.00	.14266E-06
801.00	.22150E-04
810.00	.19071E-04
819.00	.15663E-04
828.00	.10757E-04
837.00	.75462E-05
846.00	.12830E-02
855.00	.98707E-04
864.00	.31046E-04
873.00	.16180E-04
882.00	.10273E-04
891.00	.72486E-05
900.00	.11173E-02
909.00	.38001E-03
918.00	.30838E-03
927.00	.50589E-04
936.00	.10153E-02
945.00	.17965E-03
954.00	.44026E-04
963.00	.20904E-04
972.00	.12610E-04
981.00	.86061E-05
990.00	.63325E-05
999.00	.68331E-04
1008.00	.34807E-04
1017.00	.17988E-04
1026.00	.11123E-04
1035.00	.77251E-05
1044.00	.10032E-04
1053.00	.17146E-04
1062.00	.24973E-04
1071.00	.32277E-04
1080.00	.37022E-04
1089.00	.37356E-04
1098.00	.37356E-04
1107.00	.26982E-04
1116.00	.16462E-04
1125.00	.11046E-04
1134.00	.79522E-05
1143.00	.60297E-05
1152.00	.47536E-05
1161.00	.38618E-05
1170.00	.32123E-05
1179.00	.27233E-05
1188.00	.23451E-05
1197.00	.20458E-05
1206.00	.18045E-05
1215.00	.16066E-05
1224.00	.14420E-05
1233.00	.13035E-05
1242.00	.11856E-05
1251.00	.10844E-05
1260.00	.99666E-06
1269.00	.92009E-06
1278.00	.85278E-06
1287.00	.79325E-06
1296.00	.74030E-06
1305.00	.69296E-06
1314.00	.65044E-06
1323.00	.61207E-06
1332.00	.57732E-06
1341.00	.54572E-06

E-13

1350.00	.51689E-06
1359.00	.49050E-06
1368.00	.46628E-06
1377.00	.44398E-06
1386.00	.42340E-06
1395.00	.40435E-06
1404.00	.38669E-06
1413.00	.37027E-06
1422.00	.35498E-06
1431.00	.34071E-06
1440.00	.32737E-06
1449.00	.31488E-06
1458.00	.30316E-06
1467.00	.29214E-06
1476.00	.28178E-06
1485.00	0.
1494.00	0.
1503.00	0.
1512.00	0.
1521.00	0.
1530.00	0.
1539.00	0.
1548.00	0.
1557.00	0.
1566.00	0.
1575.00	0.
1584.00	0.
1593.00	0.
1602.00	0.
1611.00	0.
1620.00	0.
1629.00	0.
1638.00	0.
1647.00	0.
1656.00	0.
1665.00	0.
1674.00	0.

E-14

THE RESULTS FOR UNIT NUMBER: 3
THE TOTAL AREA IN HECTARES: .30974E+02
THE TOTAL RAINFALL IN CUBIC METERS: .10186E+05
THE TOTAL DISCHARGE IN CUBIC METERS: .12459E+05
THE TOTAL SEDIMENT YIELD IN KILOGRAMS: .59178E+04

(NOTE: THE FOLLOWING VALUES ARE PER METER WIDTH, IF THE UNIT IS A PLANE.)

THE SEDIMENT YIELD BY SIZES

SIZE IN MM	KILOGRAMS
.70711E-02	.85893E-01
.31623E-01	.18252E+00
.31623E+00	.18252E+00
.14142E+01	0.
.34641E+01	0.
.10954E+02	0.
.24495E+02	0.

FINAL HYDROGRAPH

TIME (MIN.)	DISCHARGE (CMS)
8.00	.13665E-05
16.00	.10932E-04
24.00	.36896E-04
32.00	.71216E-04
40.00	.71216E-04
48.00	.71216E-04
56.00	.71216E-04
64.00	.71216E-04
72.00	.71216E-04
80.00	.71216E-04
88.00	.71216E-04
96.00	.71216E-04
104.00	.71216E-04
112.00	.71216E-04
120	.71216E-04
128.00	.71216E-04
136.00	.71216E-04
144.00	.71216E-04
152.00	.71216E-04
160.00	.71216E-04
168.00	.71216E-04
176.00	.71216E-04
184.00	.84651E-04
192.00	.10235E-03
200.00	.10742E-03
208.00	.10752E-03
216.00	.10752E-03
224.00	.10752E-03
232.00	.10752E-03
240.00	.10752E-03
248.00	.10752E-03
256.00	.10752E-03
264.00	.10752E-03
272.00	.10752E-03
280.00	.10752E-03
288.00	.10752E-03
296.00	.10752E-03
304.00	.10752E-03
312.00	.10752E-03
320.00	.10752E-03
328.00	.10752E-03
336.00	.10752E-03
344.00	.10752E-03

E-15

352.00	.10752E-03
360.00	.10752E-03
368.00	.93550E-04
376.00	.88595E-04
384.00	.87644E-04
392.00	.87637E-04
400.00	.87637E-04
408.00	.87637E-04
416.00	.87637E-04
424.00	.87637E-04
432.00	.87637E-04
440.00	.87637E-04
448.00	.87637E-04
456.00	.87637E-04
464.00	.87637E-04
472.00	.87637E-04
480.00	.87637E-04
488.00	.87637E-04
496.00	.87637E-04
504.00	.87637E-04
512.00	.87637E-04
520.00	.87637E-04
528.00	.87637E-04
536.00	.87637E-04
544.00	.64498E-04
552.00	.41523E-04
560.00	.31715E-04
568.00	.27068E-04
576.00	.24791E-04
584.00	.23729E-04
592.00	.23317E-04
600.00	.23225E-04
608.00	.23223E-04
616.00	.23223E-04
624.00	.23223E-04
632.00	.23223E-04
640.00	.23223E-04
648.00	.23223E-04
656.00	.23223E-04
664.00	.23223E-04
672.00	.23223E-04
680.00	.23223E-04
688.00	.23223E-04
696.00	.23223E-04
704.00	.23223E-04
712.00	.23223E-04
720.00	.23224E-04
728.00	.16256E-04
736.00	.11904E-04
744.00	.90644E-05
752.00	.71326E-05
760.00	.57670E-05
768.00	.47688E-05
776.00	.40177E-05
784.00	.34384E-05
792.00	.29818E-05
800.00	.26154E-05
808.00	.23165E-05
816.00	.20692E-05
824.00	.18621E-05
832.00	.16868E-05
840.00	.15369E-05
848.00	.14075E-05
856.00	.12951E-05
864.00	.11967E-05
872.00	.11100E-05
880.00	.10332E-05
888.00	.96473E-06
896.00	.90342E-06
904.00	.84828E-06

192.00	.77716E-04
200.00	.84140E-04
208.00	.84972E-04
216.00	.84972E-04
224.00	.84972E-04
232.00	.84972E-04
240.00	.84972E-04
248.00	.84972E-04
256.00	.84972E-04
264.00	.84972E-04
272.00	.84972E-04
280.00	.84972E-04
288.00	.84972E-04
296.00	.84972E-04
304.00	.84972E-04
312.00	.84972E-04
320.00	.84972E-04
328.00	.84972E-04
336.00	.84972E-04
344.00	.84972E-04
352.00	.84972E-04
360.00	.84972E-04
368.00	.79163E-04
376.00	.76640E-04
384.00	.75928E-04
392.00	.75884E-04
400.00	.75884E-04
408.00	.75884E-04
416.00	.75884E-04
424.00	.75884E-04
432.00	.75884E-04
440.00	.75884E-04
448.00	.75884E-04
456.00	.75884E-04
464.00	.75884E-04
472.00	.75884E-04
480.00	.75884E-04
488.00	.75884E-04
496.00	.75884E-04
504.00	.75884E-04
512.00	.75884E-04
520.00	.75884E-04
528.00	.75884E-04
536.00	.75884E-04
544.00	.61039E-04
552.00	.44720E-04
560.00	.37213E-04
568.00	.33704E-04
576.00	.32182E-04
584.00	.31671E-04
592.00	.31599E-04
600.00	.31599E-04
608.00	.31599E-04
616.00	.31599E-04
624.00	.31599E-04
632.00	.31599E-04
640.00	.31599E-04
648.00	.31599E-04
656.00	.31599E-04
664.00	.31599E-04
672.00	.31599E-04
680.00	.31599E-04
688.00	.31599E-04
696.00	.31599E-04
704.00	.31599E-04
712.00	.31599E-04
720.00	.31599E-04
728.00	.20653E-04
736.00	.14392E-04
744.00	.10578E-04

E-17

752.00	.81135E-05
760.00	.64380E-05
768.00	.52490E-05
776.00	.43739E-05
784.00	.37114E-05
792.00	.31969E-05
800.00	.27886E-05
808.00	.24587E-05
816.00	.21880E-05
824.00	.19628E-05
832.00	.17732E-05
840.00	.16119E-05
848.00	.14733E-05
856.00	.13533E-05
864.00	.12485E-05
872.00	.11565E-05
880.00	.10752E-05
888.00	.10028E-05
896.00	.93821E-06
904.00	.88019E-06
912.00	.82786E-06
920.00	.78049E-06
928.00	.73744E-06
936.00	.69818E-06
944.00	.66227E-06
952.00	.62932E-06
960.00	.59899E-06
968.00	.57102E-06
976.00	.54514E-06
984.00	.52115E-06
992.00	.49887E-06
1000.00	.47812E-06
1008.00	.45876E-06
1016.00	.44068E-06
1024.00	.42374E-06
1032.00	.40786E-06
1040.00	.39294E-06
1048.00	.37891E-06
1056.00	.36569E-06
1064.00	.35322E-06
1072.00	.34144E-06
1080.00	.33030E-06
1088.00	.31975E-06
1096.00	.30975E-06
1104.00	.30025E-06
1112.00	.29124E-06
1120.00	.28266E-06
1128.00	0.
1136.00	0.
1144.00	0.
1152.00	0.
1160.00	0.
1168.00	0.
1176.00	0.
1184.00	0.
1192.00	0.
1200.00	0.
1208.00	0.
1216.00	0.
1224.00	0.
1232.00	0.
1240.00	0.
1248.00	0.
1256.00	0.
1264.00	0.
1272.00	0.
1280.00	0.
1288.00	0.
1296.00	0.
1304.00	0.

THE RESULTS FOR THE DOWNSTREAM OUTLET OF THE WATERSHED:

THE TOTAL RUNOFF IN CUBIC METERS: .83192E+05

THE SEDIMENT YIELD BY SIZES:

SIZE IN MM	KILOGRAMS
.70711E-02	.85676E+05
.31623E-01	.18349E+06
.31623E+00	.18909E+06
.14142E+01	.33958E+04
.34641E+01	.98612E+01
.10954E+02	.98260E+01
.24495E+02	.46534E+01

FINAL HYDROGRAPH

TIME (MIN.)	DISCHARGE (CMS)
.90000E+01	.48339E+01
.18000E+02	.87313E+01
.27000E+02	.43168E+01
.36000E+02	.11581E+02
.45000E+02	.19426E+02
.54000E+02	.11395E+02
.63000E+02	.74415E+01
.72000E+02	.93375E+01
.81000E+02	.46846E+01
.90000E+02	.15097E+01
.99000E+02	.46531E+00
.10800E+03	.16780E+00
.11700E+03	.71876E-01
.12600E+03	.33485E-01
.13500E+03	.14902E-01
.14400E+03	.48294E-02
.15300E+03	.99968E-03
.16200E+03	.26337E-03
.17100E+03	.83846E-04
.18000E+03	.31019E-04
.18900E+03	.12947E-04
.19800E+03	.24820E-01
.20700E+03	.87362E-01
.21600E+03	.83818E-01
.22500E+03	.61258E-01
.23400E+03	.41747E-01
.24300E+03	.26891E-01
.25200E+03	.15888E-01
.26100E+03	.78382E-02
.27000E+03	.22481E-02
.27900E+03	.52431E-03
.28800E+03	.15166E-03
.29700E+03	.51985E-04
.30600E+03	.20404E-04
.31500E+03	.89346E-05
.32400E+03	.42784E-05
.33300E+03	.22062E-05
.34200E+03	.94430E-05
.35100E+03	.44958E-05
.36000E+03	.23072E-05

E-19

.36900E+03	0.
.37800E+03	0.
.38700E+03	0.
.39600E+03	0.
.40500E+03	.15922E-04
.41400E+03	.71668E-05
.42300E+03	.35108E-05
.43200E+03	.18451E-05
.44100E+03	.22054E-05
.45000E+03	0.
.45900E+03	0.
.46800E+03	0.
.47700E+03	0.
.48600E+03	0.
.49500E+03	0.
.50400E+03	0.
.51300E+03	0.
.52200E+03	0.
.53100E+03	0.
.54000E+03	0.
.54900E+03	0.
.55800E+03	0.
.56700E+03	0.
.57600E+03	0.
.58500E+03	0.
.59400E+03	0.
.60300E+03	0.
.61200E+03	0.
.62100E+03	0.
.63000E+03	0.
.63900E+03	0.
.64800E+03	0.
.65700E+03	0.
.66600E+03	0.
.67500E+03	0.
.68400E+03	0.
.69300E+03	0.
.70200E+03	0.
.71100E+03	0.
.72000E+03	0.
.72900E+03	.47408E-06
.73800E+03	0.
.74700E+03	0.
.75600E+03	0.
.76500E+03	.26844E-05
.77400E+03	.28602E-05
.78300E+03	.29206E-05
.79200E+03	.28863E-05
.80100E+03	.14582E+00
.81000E+03	.17008E-01
.81900E+03	.19673E-01
.82800E+03	.77718E-01
.83700E+03	.54446E-01
.84600E+03	.12498E+02
.85500E+03	.65965E+01
.86400E+03	.17871E+01
.87300E+03	.48743E+00
.88200E+03	.16471E+00
.89100E+03	.69158E-01
.90000E+03	.95258E+01
.90900E+03	.76605E+01
.91800E+03	.55275E+01
.92700E+03	.22908E+01
.93600E+03	.93920E+01
.94500E+03	.54770E+01
.95400E+03	.19018E+01
.96300E+03	.60238E+00
.97200E+03	.21952E+00
.98100E+03	.95290E-01
.99000E+03	.45918E-01
.99900E+03	.52221E+00
.10080E+04	.47452E+00
.10170E+04	.27648E+00

E-20

.10260E+04	.14459E+00
.10350E+04	.73305E-01
.10440E+04	.69241E-01
.10530E+04	.12486E+00
.10620E+04	.20555E+00
.10710E+04	.29188E+00
.10800E+04	.36538E+00
.10890E+04	.40305E+00
.10980E+04	.41760E+00
.11070E+04	.33546E+00
.11160E+04	.21082E+00
.11250E+04	.11970E+00
.11340E+04	.66386E-01
.11430E+04	.36048E-01
.11520E+04	.18358E-01
.11610E+04	.77435E-02
.11700E+04	.15355E-02
.11790E+04	.37947E-03
.11880E+04	.11487E-03
.11970E+04	.40826E-04
.12060E+04	.16497E-04
.12150E+04	.39080E-04
.12240E+04	.15874E-04
.12330E+04	.71476E-05
.12420E+04	.35024E-05
.12510E+04	.18410E-05
.12600E+04	.23977E-05
.12690E+04	0.
.12780E+04	0.
.12870E+04	0.
.12960E+04	0.
.13050E+04	.15187E-04
.13140E+04	.68715E-05
.13230E+04	.33806E-05
.13320E+04	.31013E-05
.13410E+04	.28099E-05
.13500E+04	0.
.13590E+04	0.
.13680E+04	0.
.13770E+04	0.
.13860E+04	0.
.13950E+04	0.
.14040E+04	0.
.14130E+04	0.
.14220E+04	0.
.14310E+04	0.
.14400E+04	0.
.14490E+04	0.
.14580E+04	0.
.14670E+04	0.
.14760E+04	0.
.14850E+04	.17583E-04
.14940E+04	.78283E-05
.15030E+04	.38003E-05
.15120E+04	.19822E-05
.15210E+04	.23531E-05
.15300E+04	.38578E-05
.15390E+04	.26092E-05
.15480E+04	.21534E-05
.15570E+04	0.
.15660E+04	0.
.15750E+04	0.
.15840E+04	0.
.15930E+04	0.
.16020E+04	0.
.16110E+04	0.
.16200E+04	0.
.16290E+04	0.
.16380E+04	0.
.16470E+04	0.
.16560E+04	0.
.16650E+04	.62860E-05
.16740E+04	.31206E-05

FOREST MANAGEMENT ALTERNATIVES

NUMBER OF NUTRIENT CHANGES BY MANAGEMENT = 0

NITROGEN AND PHOSPHORUS LOADINGS FROM EACH WATERSHED PLANE(AMOUNT OF NUTRIENTS IN KILOGRAM)

PLANE NUMBER=	1
TOTAL NITROGEN=	.6455528E+03
NITRATE=	.2541041E+01
AMMONIUM=	.1117084E+02
TOTAL PHOSPHORUS=	.1464107E+02
ORGANIC PHOSPHORUS=	.2529309E+03
INORGANIC PHOSPHORUS=	.7793956E+00

NUMBER OF NUTRIENT CHANGES BY MANAGEMENT = 0

NITROGEN AND PHOSPHORUS LOADINGS FROM EACH WATERSHED PLANE(AMOUNT OF NUTRIENTS IN KILOGRAM)

PLANE NUMBER=	2
TOTAL NITROGEN=	.6283615E+03
NITRATE=	.2189605E+01
AMMONIUM=	.9623639E+01
TOTAL PHOSPHORUS=	.1264617E+02
ORGANIC PHOSPHORUS=	.2530557E+03
INORGANIC PHOSPHORUS=	.6728633E+00

NUMBER OF NUTRIENT CHANGES BY MANAGEMENT = 0

NITROGEN AND PHOSPHORUS LOADINGS FROM EACH WATERSHED PLANE(AMOUNT OF NUTRIENTS IN KILOGRAM)

PLANE NUMBER=	3
TOTAL NITROGEN=	.6301570E+03
NITRATE=	.2490381E+01
AMMONIUM=	.1094843E+02
TOTAL PHOSPHORUS=	.1433143E+02
ORGANIC PHOSPHORUS=	.2469407E+03
INORGANIC PHOSPHORUS=	.7638617E+00

NUMBER OF NUTRIENT CHANGES BY MANAGEMENT = 0

NITROGEN AND PHOSPHORUS LOADINGS FROM EACH WATERSHED PLANE(AMOUNT OF NUTRIENTS IN KILOGRAM)

E-22

PLANE NUMBER=	4
TOTAL NITROGEN=	.6146857E+03
NITRATE=	.2411906E+01
AMMONIUM=	.1059127E+02
TOTAL PHOSPHORUS=	.1391853E+02
ORGANIC PHOSPHORUS=	.2411840E+03
INORGANIC PHOSPHORUS=	.7381687E+00

TOTAL NITROGEN LOADINGS FROM MULTIWATERSHEDS(KG)

TOTAL NITROGEN	NITRATE	AMMONIUM
.2518757E+04	.9632933E+01	.4233418E+02

TOTAL PHOSPHORUS LOADINGS FROM MULTIWATERSHEDS(KG)

TOTAL PHOSPHORUS	ORGANIC PHOSPHORUS	INORGANIC PHOSPHORUS
.5553720E+02	.9941113E+03	.2954289E+01

E-23

STORM NUMBER=	1
SURFACE WATER TEMPERATURE(C)=	.126E+02
RUNOFF WATER TEMPERATURE(C)=	.182E+02
THERMAL LOADING(KJ)=	.221E+10
AVERAGE DISSOLVED OXYGEN(MG)=	.806E+01

STORM NUMBER=	2
SURFACE WATER TEMPERATURE(C)=	.139E+02
RUNOFF WATER TEMPERATURE(C)=	.202E+02
THERMAL LOADING(KJ)=	.927E+09
AVERAGE DISSOLVED OXYGEN(MG)=	.773E+01

STORM NUMBER=	3
SURFACE WATER TEMPERATURE(C)=	.195E+02
RUNOFF WATER TEMPERATURE(C)=	.296E+02
THERMAL LOADING(KJ)=	.817E+09
AVERAGE DISSOLVED OXYGEN(MG)=	.643E+01

STORM NUMBER=	4
SURFACE WATER TEMPERATURE(C)=	.185E+02
RUNOFF WATER TEMPERATURE(C)=	.170E+02
THERMAL LOADING(KJ)=	-.164E+09
AVERAGE DISSOLVED OXYGEN(MG)=	.827E+01

STORM NUMBER=	5
SURFACE WATER TEMPERATURE(C)=	.709E+01
RUNOFF WATER TEMPERATURE(C)=	.118E+02

E-24

THERMAL LOADING(KJ)=	.984E+09
AVERAGE DISSOLVED OXYGEN(MG)=	.930E+01

STORM NUMBER=	6
SURFACE WATER TEMPERATURE(C)=	.709E+01
RUNOFF WATER TEMPERATURE(C)=	.115E+02
THERMAL LOADING(KJ)=	.146E+10
AVERAGE DISSOLVED OXYGEN(MG)=	.937E+01

STORM NUMBER=	7
SURFACE WATER TEMPERATURE(C)=	.709E+01
RUNOFF WATER TEMPERATURE(C)=	.100E+02
THERMAL LOADING(KJ)=	.517E+09
AVERAGE DISSOLVED OXYGEN(MG)=	.971E+01

E-25

```
THE CHANNEL NUMBER IS   1
THE SECTION NUMBER IS   1


TOTAL AMOUNT OF BANK EROSION=          0.

SUSPENDED AMOUNT OF BANK EROSION=      0.

QPKYEAR=      .1219375639E+02  APKYEAR=      .1602561196E+01
QEQU=         .2831865000E+02  AEQU=         .2401338400E+02

THE CHANNEL NUMBER IS   1
THE SECTION NUMBER IS   2


TOTAL AMOUNT OF BANK EROSION=          0.
SUSPENDED AMOUNT OF BANK EROSION=      0.

QPKYEAR=      .1392613892E+02  APKYEAR=      .1782252324E+01
QEQU=         .2831865000E+02  AEQU=         .2401338400E+02

THE CHANNEL NUMBER IS   1
THE SECTION NUMBER IS   3


TOTAL AMOUNT OF BANK EROSION=          0.
SUSPENDED AMOUNT OF BANK EROSION=      0.

QPKYEAR=      .1586081163E+02  APKYEAR=      .1977720599E+01
QEQU=         .2831865000E+02  AEQU=         .2401338400E+02

THE CHANNEL NUMBER IS   1
THE SECTION NUMBER IS   4


TOTAL AMOUNT OF BANK EROSION=          0.
SUSPENDED AMOUNT OF BANK EROSION=      0.

QPKYEAR=      .1773646325E+02  APKYEAR=      .2162709709E+01
QEQU=         .2831865000E+02  AEQU=         .2401338400E+02

THE CHANNEL NUMBER IS   1
THE SECTION NUMBER IS   5


TOTAL AMOUNT OF BANK EROSION=          0.
SUSPENDED AMOUNT OF BANK EROSION=      0.

QPKYEAR=      .1953832310E+02  APKYEAR=      .2336761781E+01
QEQU=         .2831865000E+02  AEQU=         .2401338400E+02
```

```
TRATIO =      .48765  RILAV =      .50000  PEAKRIL =     48.74660
PEAKEX =      .00007  PRECU =      .00000

FLOD =    1781012.74  PEAK =     19.19158

TRATIO =      .48765  RILAV =      .50000  PEAKRIL =     30.85481
PEAKEX =      .00007  PRECU =      .00000

FLOD =    1534401.62  PEAK =     12.14756

TRATIO =      .48765  RILAV =      .50000  PEAKRIL =     35.83071
PEAKEX =      .00007  PRECU =      .00000

FLOD =    1745487.71  PEAK =     14.10658

TRATIO =      .48765  RILAV =      .50000  PEAKRIL =     45.35673
PEAKEX =      .00007  PRECU =      .00000

FLOD =    1691684.25  PEAK =     17.85698
```

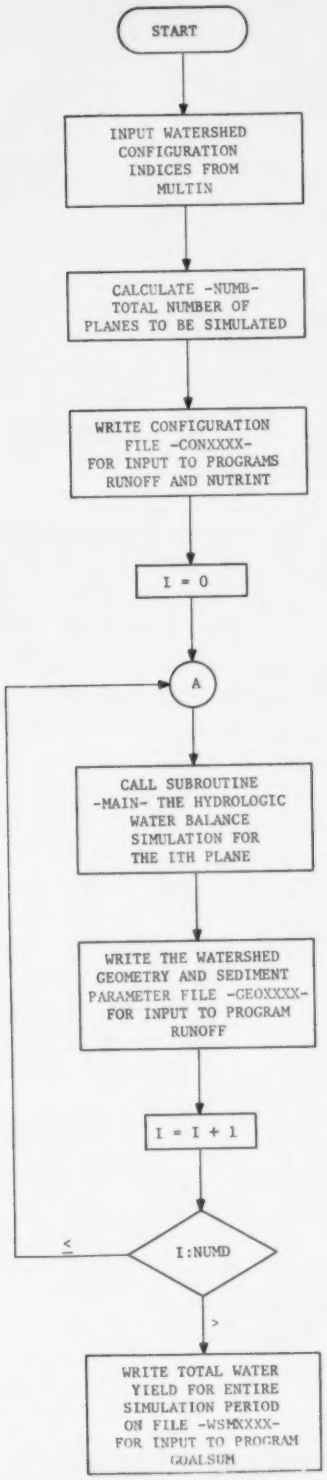
T

```
PREVIOUS MULTI-YEAR TOTALS OF SIGNIFICANT YIELDS.
                                   0.
                                   0.
                                   0.
                                   0.
                                   0.
                                   0.
                                   0.

THE TOTAL WATER YIELD =                          18.82184  CM
THE TOTAL SEDIMENT YIELD =                    1157305.88800  KG
THE TOTAL DISSOLVED OXYGEN =             3090162265.00000  MG
THE TOTAL TEMPERATURE LOADING =          6752568328.00000  KJ
THE TOTAL NITROGEN =                          2518.75700  KG
THE TOTAL PHOSPHORUS =                          55.53720  KG
THE TOTAL LITTER LOADING =                    6752586.32200  KG

UPDATED MULTI-YEAR TOTALS OF SIGNIFICANT YIELDS.
                                   18.82184123
                                   1157305.888
                                   3090162265.
                                   6752568328.
                                   2518.756998
                                   55.53720074
                                   6752586.322
```

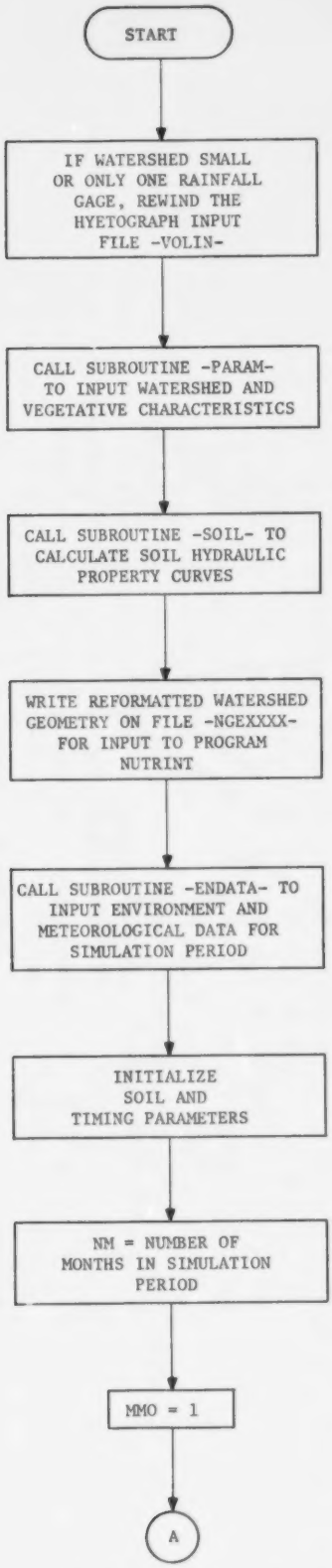
APPENDIX F

FLOW CHARTS

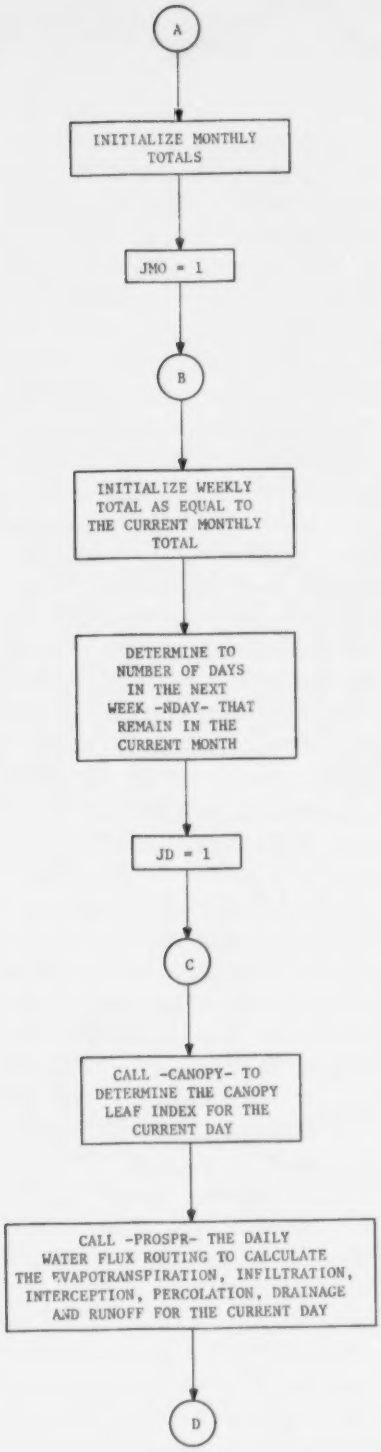
This appendix contains flow charts for the more complex routines of the hydrologic simulator. Not all routines are included since many are very straightforward. In order to more easily present the overall logic of some programs, some flow charts combine more than one routine. These flow charts refer to calculations rather than individual subroutines or programs.



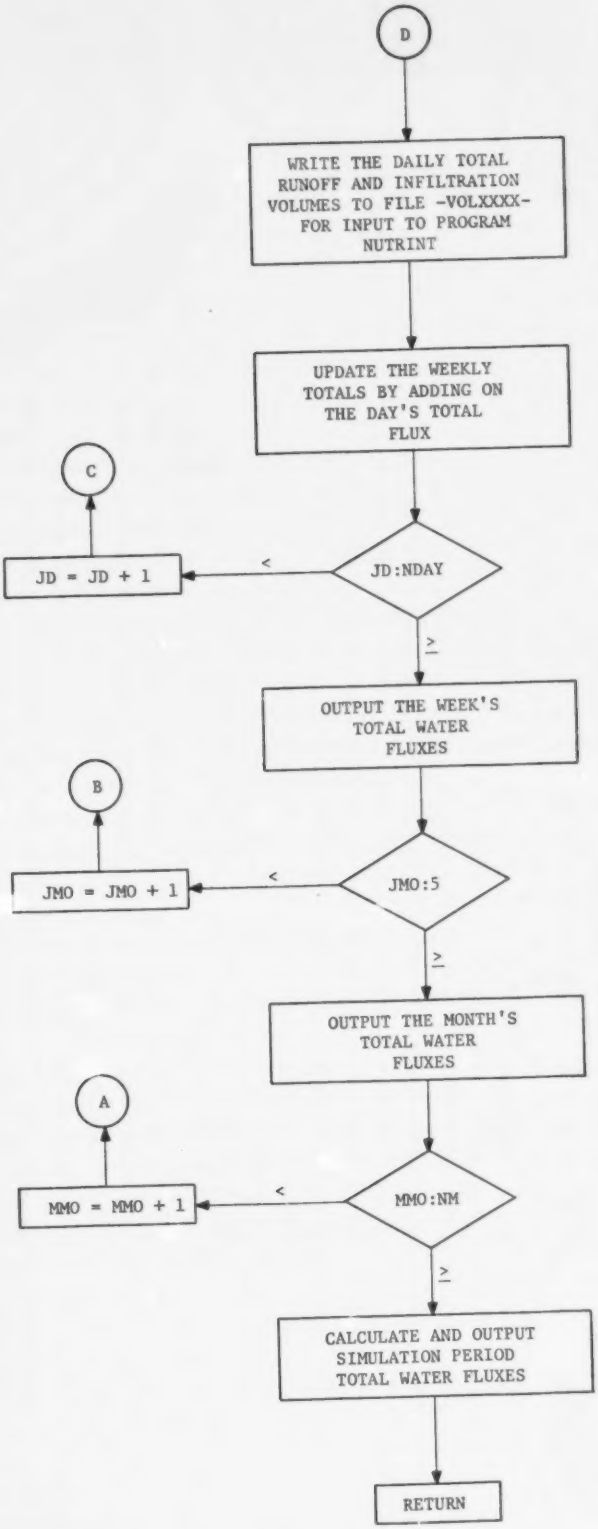
Flow chart of Program HYDROL.



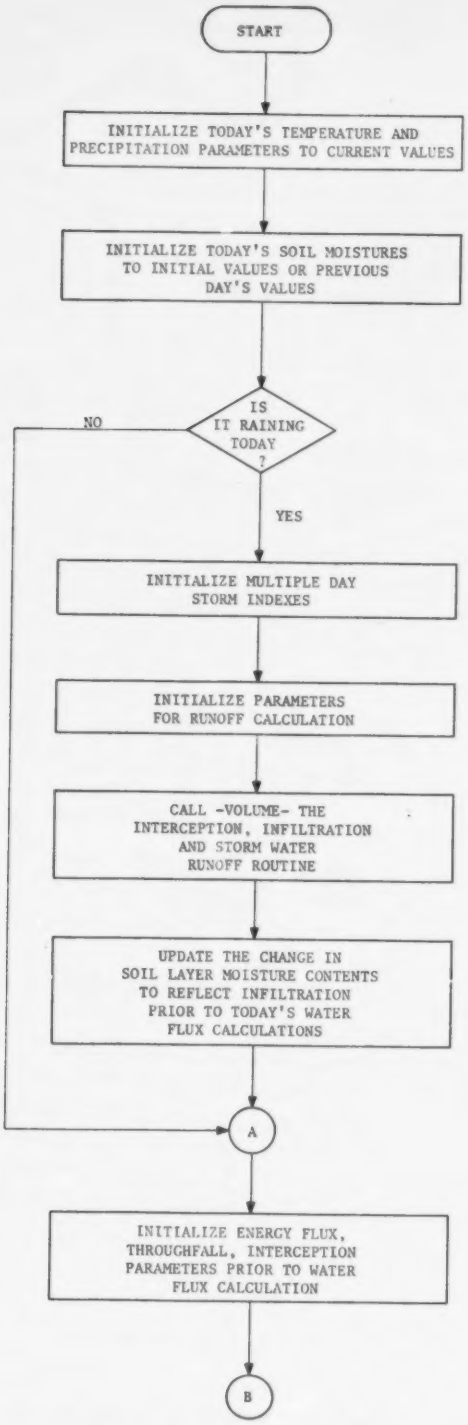
Flow chart of Subroutine MAIN, Program HYDROL.



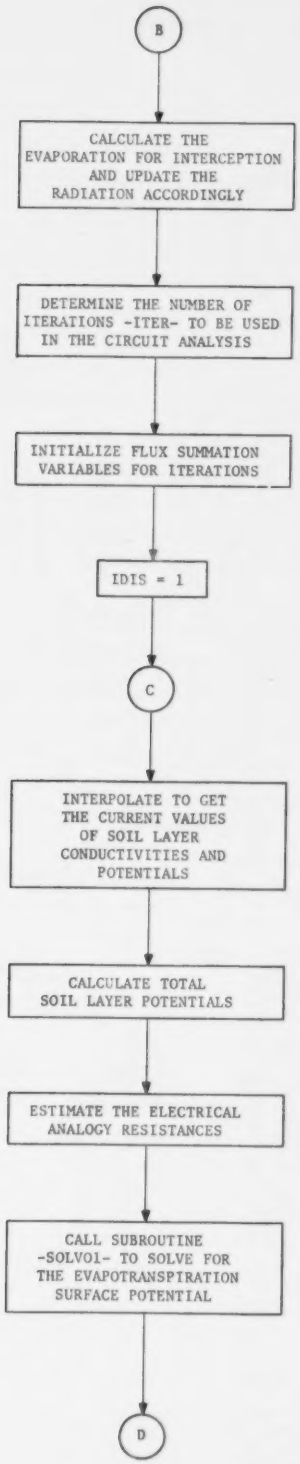
Flow chart of Subroutine MAIN, Program HYDROL.



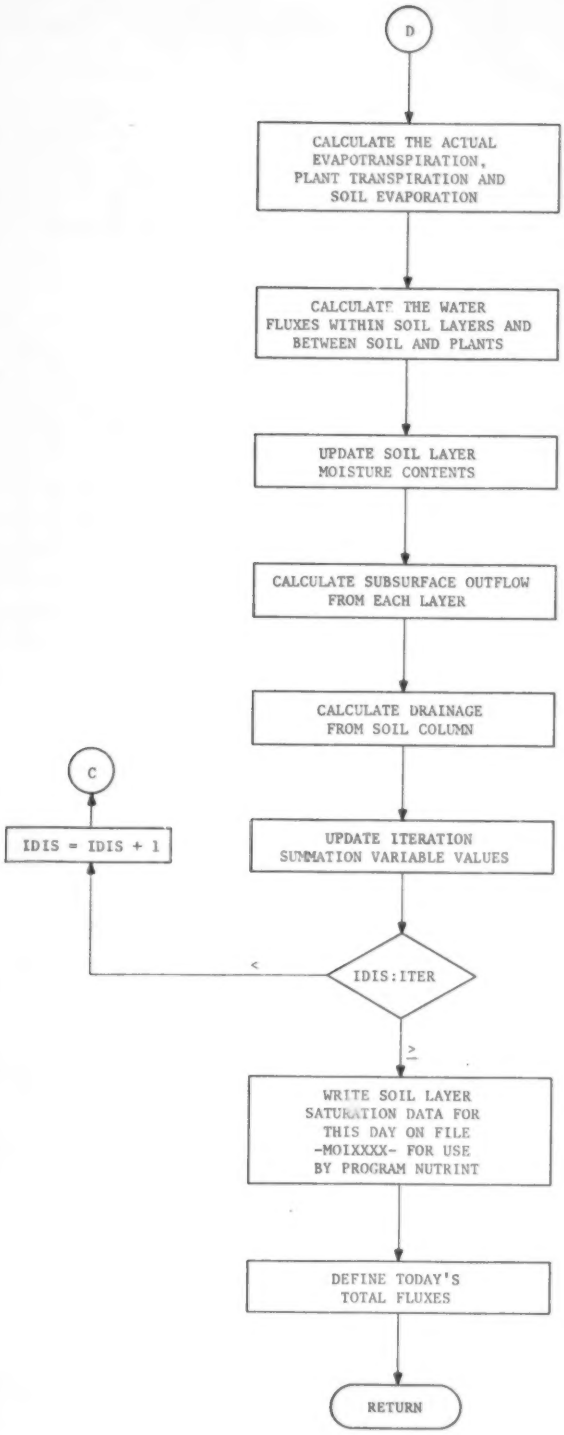
Flow chart of Subroutine MAIN, Program HYDROL.



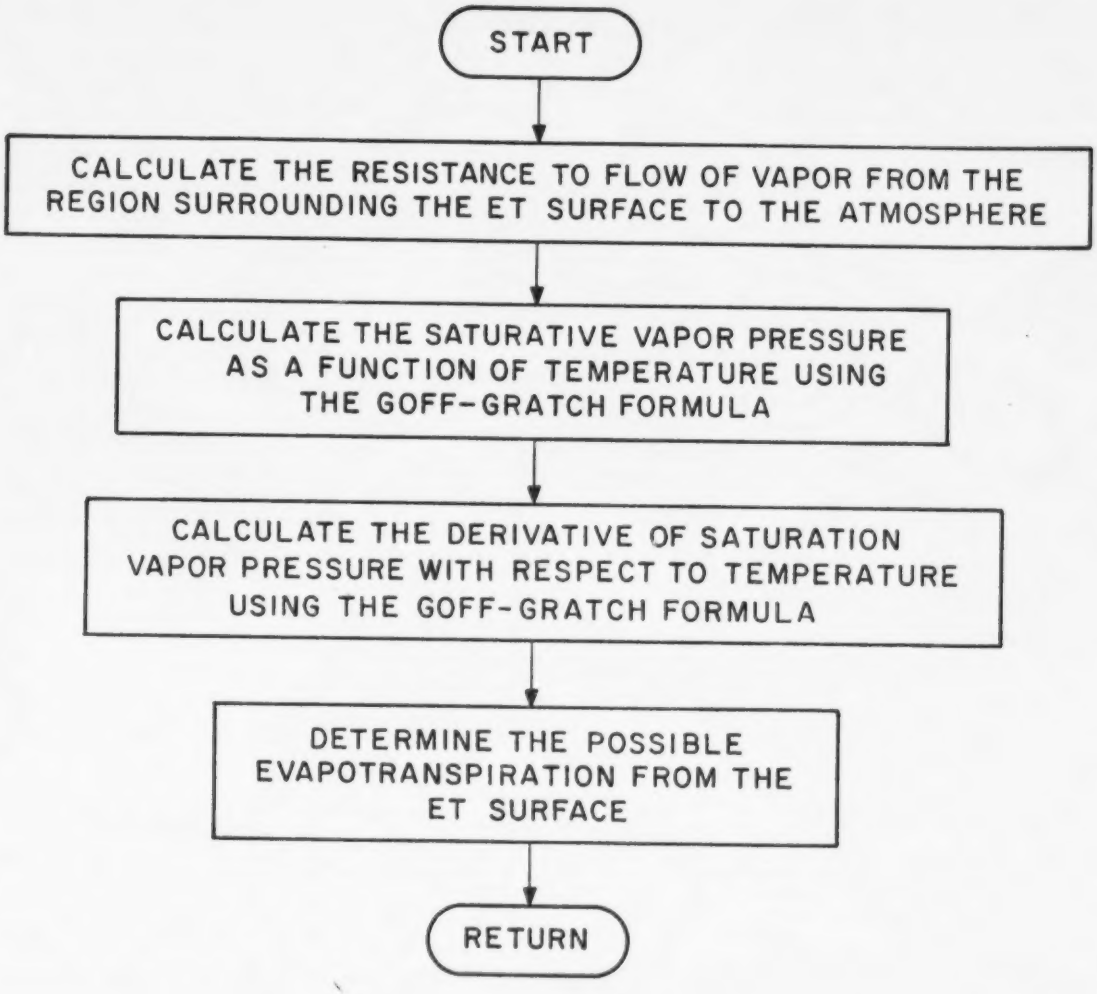
Flow chart of Subroutine PROSPR, Program HYDROL.



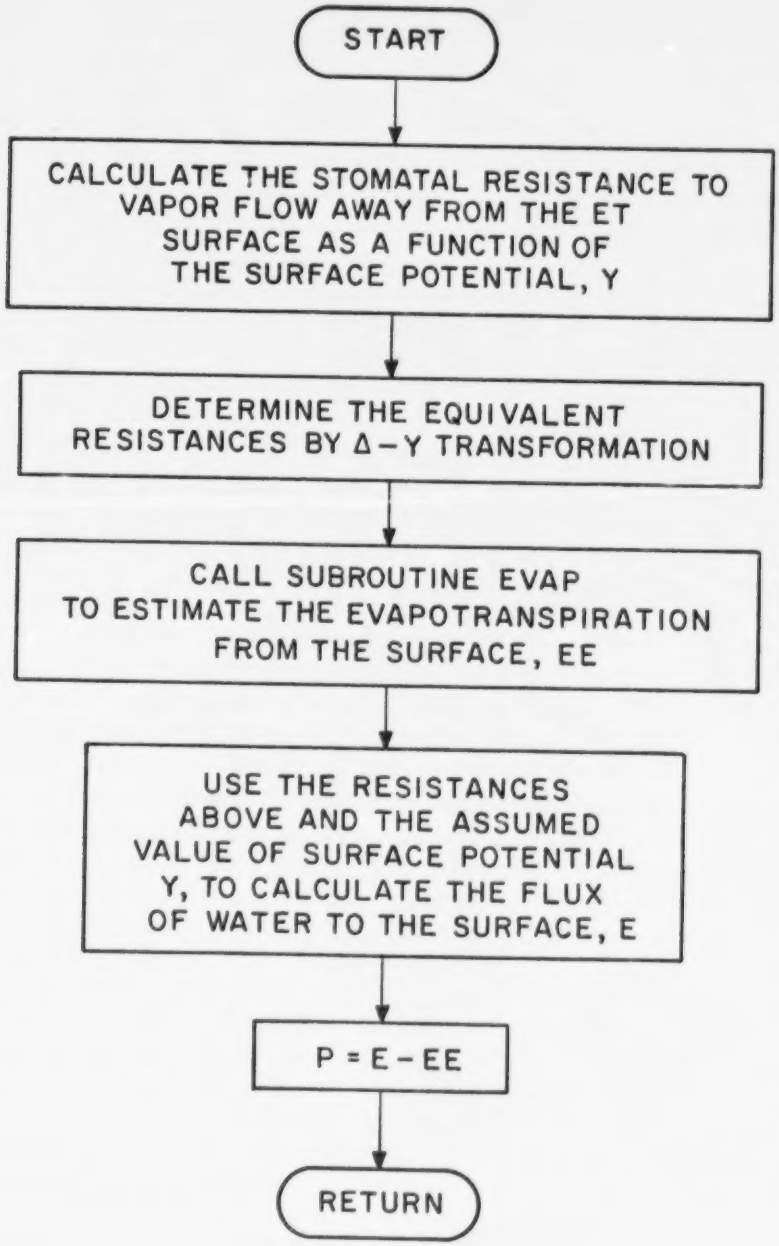
Flow chart of Subroutine PROSPR, Program HYDROL.



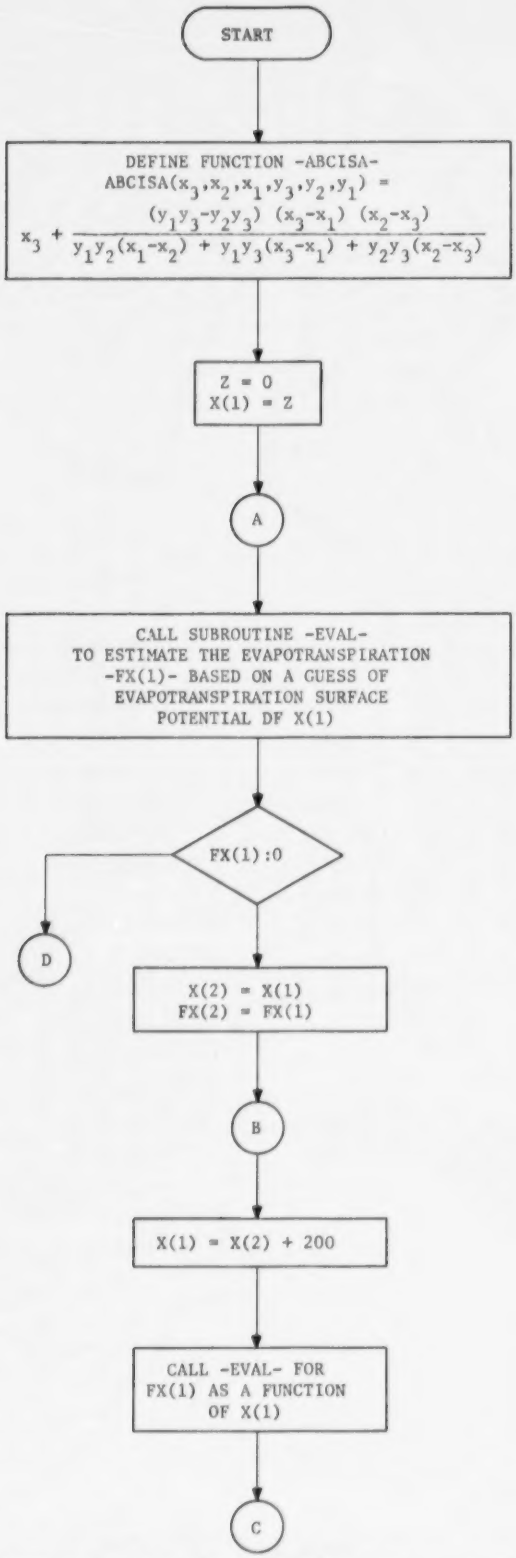
Flow chart of Subroutine PROSPR, Program HYDROL.



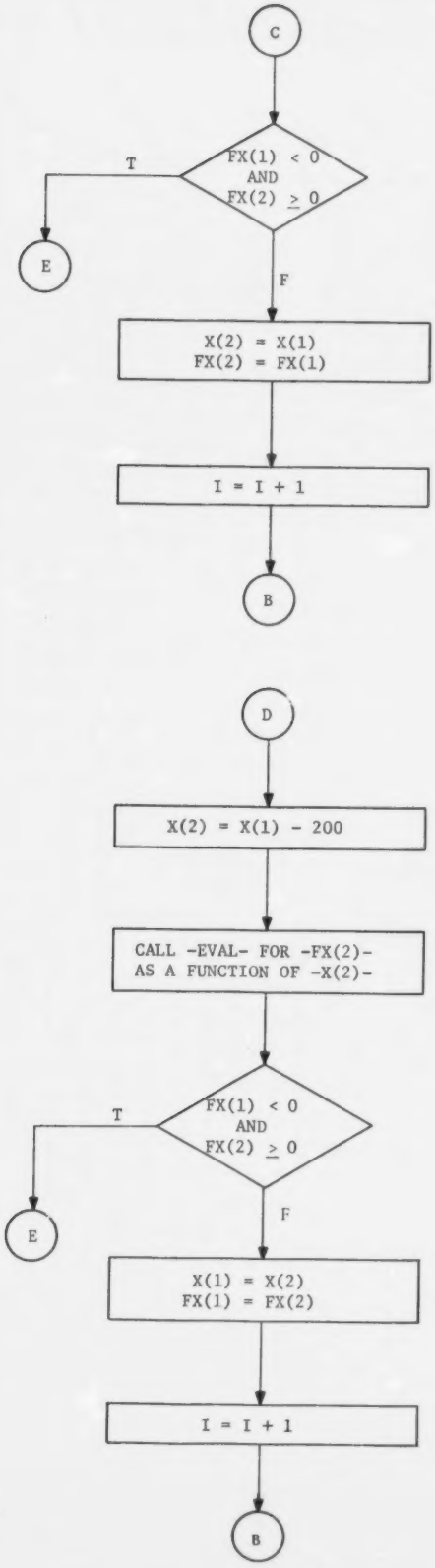
Flow chart of Subroutine EVAP, Program HYDROL.



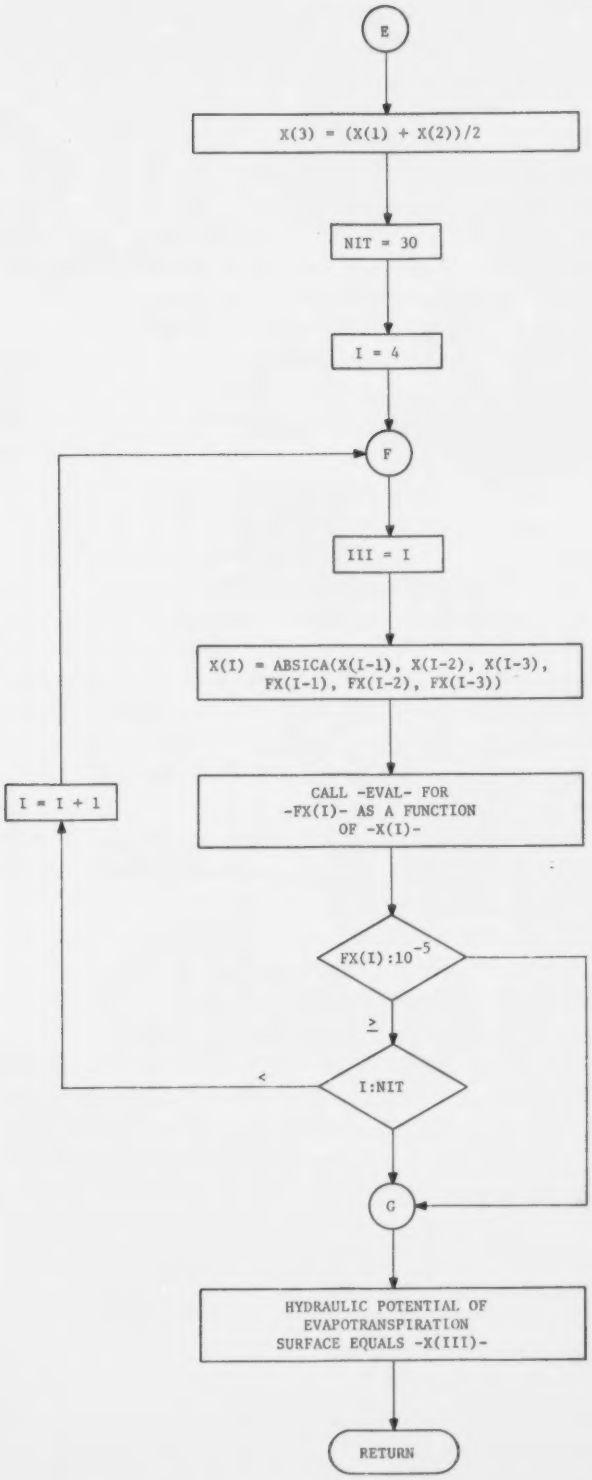
Flow chart of Subroutine EVAP, Program HYDROL.



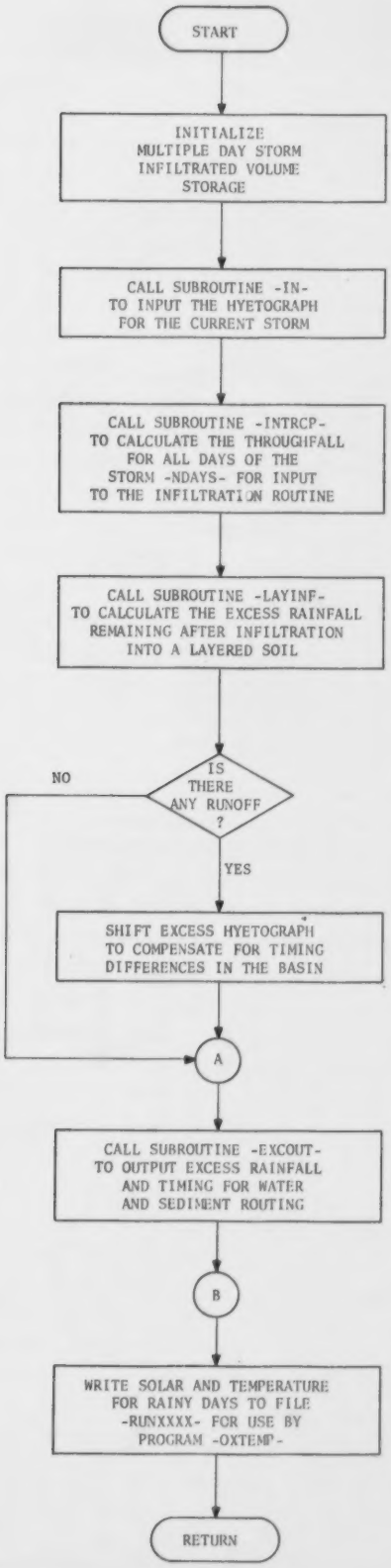
Flow chart of Subroutine SOLV01, Program HYDROL.



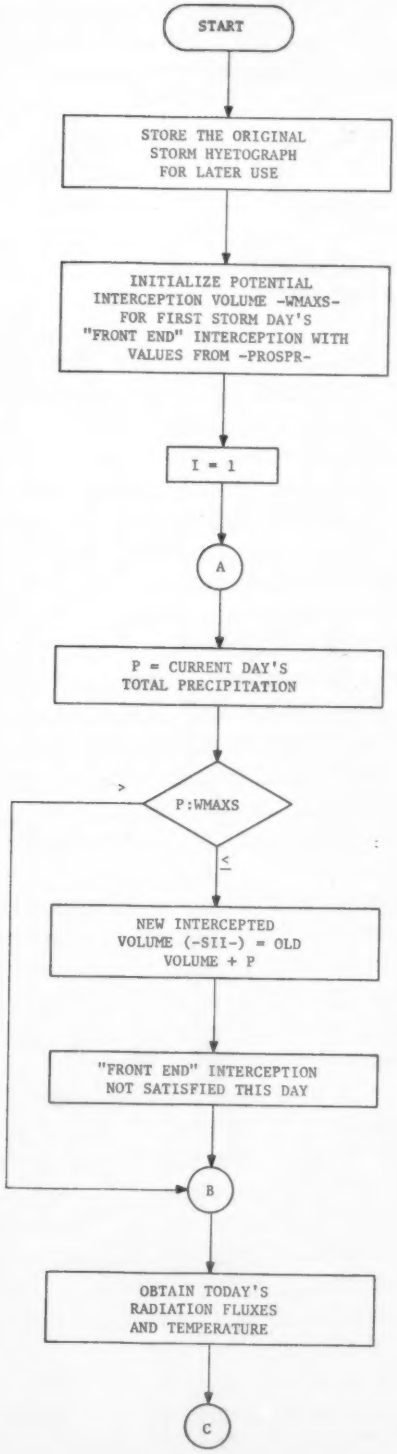
Flow chart of Subroutine SOLV01, Program HYDROL.



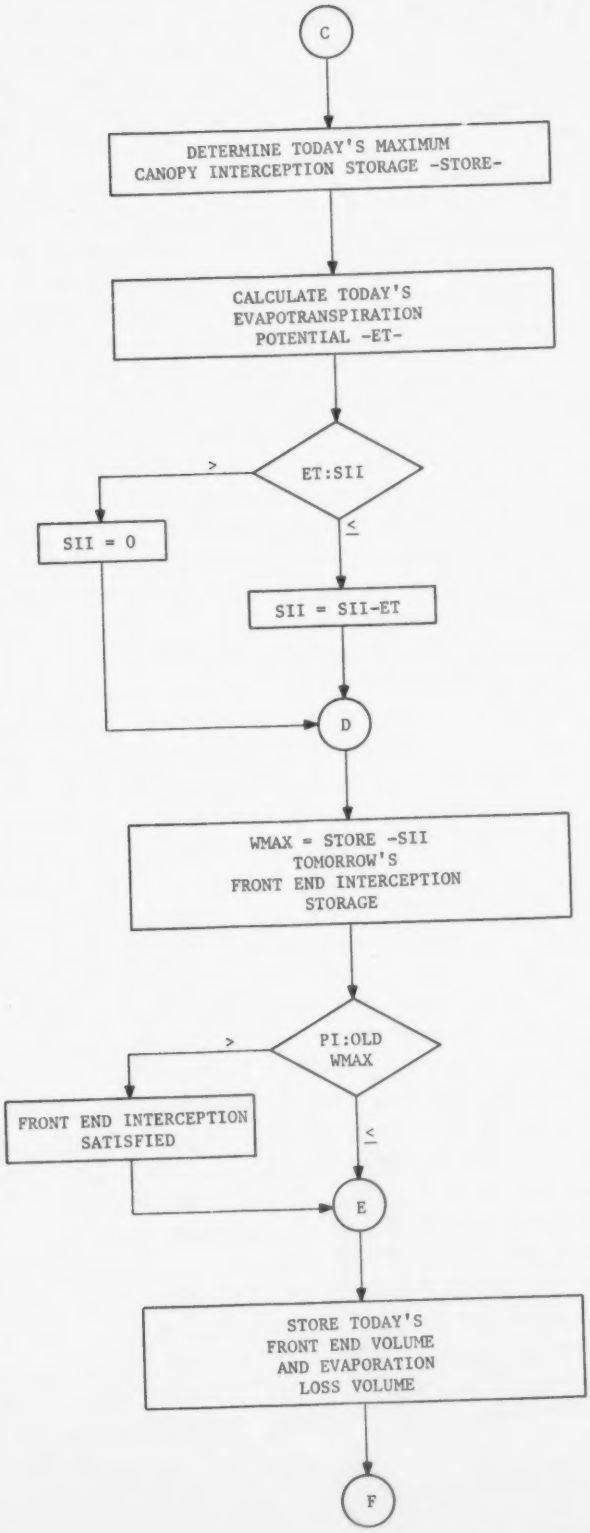
Flow chart of Subroutine SOLVO1, Program HYDROL.



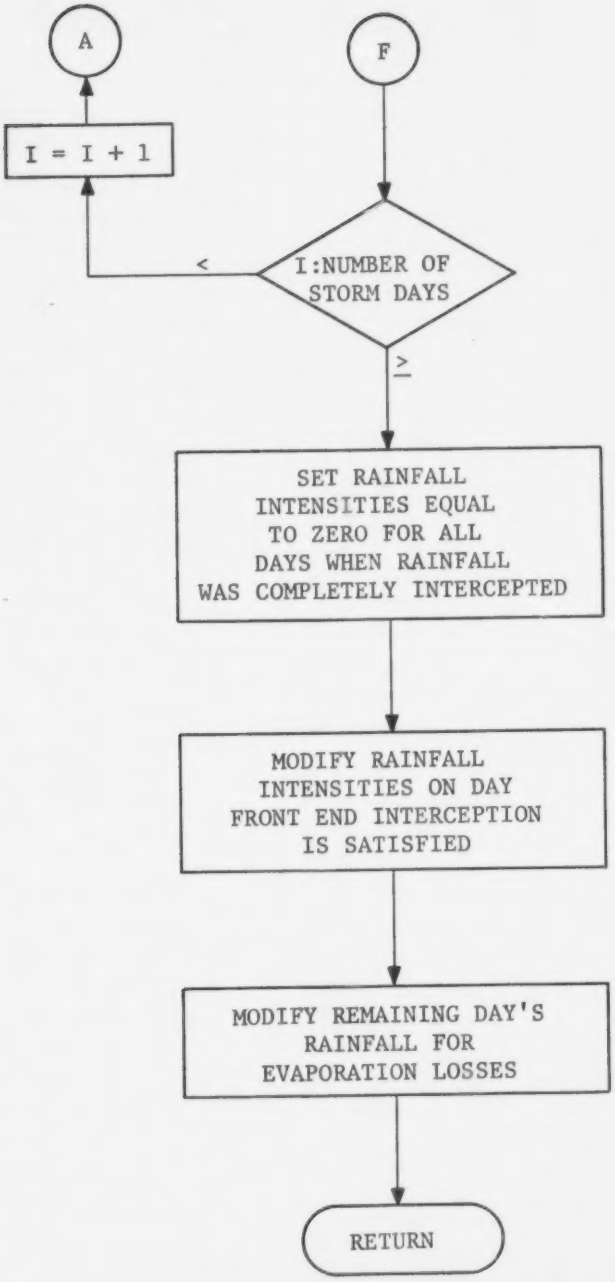
Flow chart of Subroutine VOLUME, Program HYDROL.



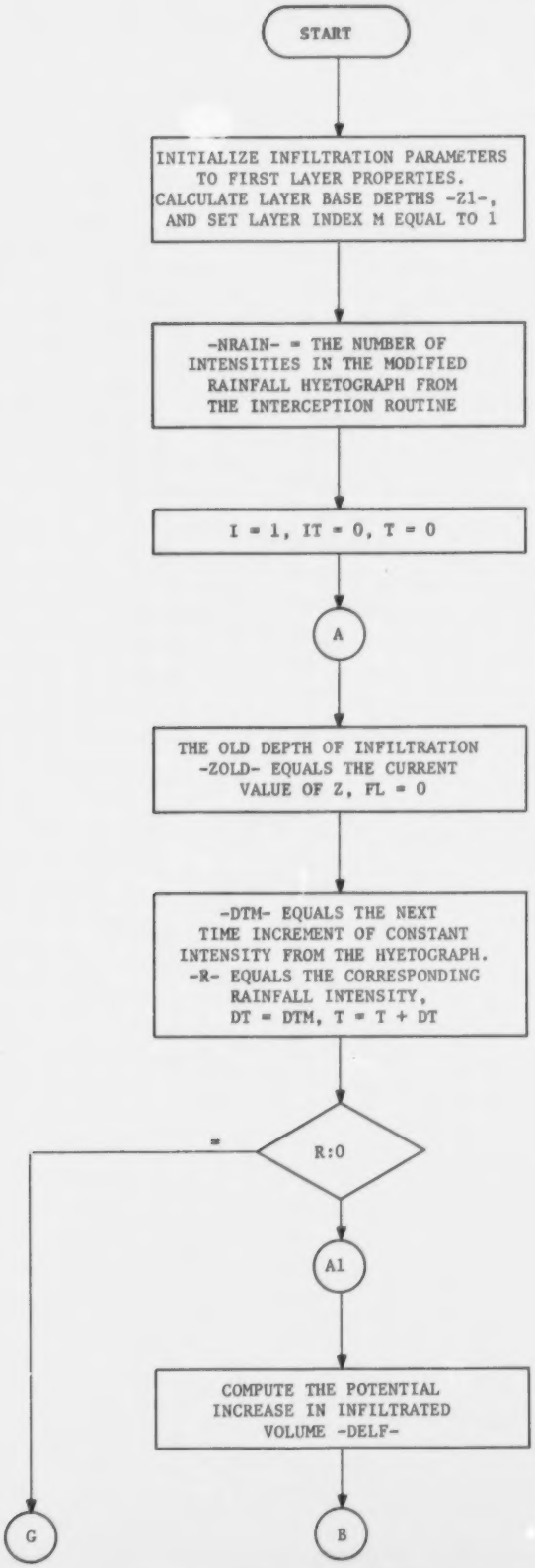
Flow chart of Subroutine INTRCP, Program HYDROL.



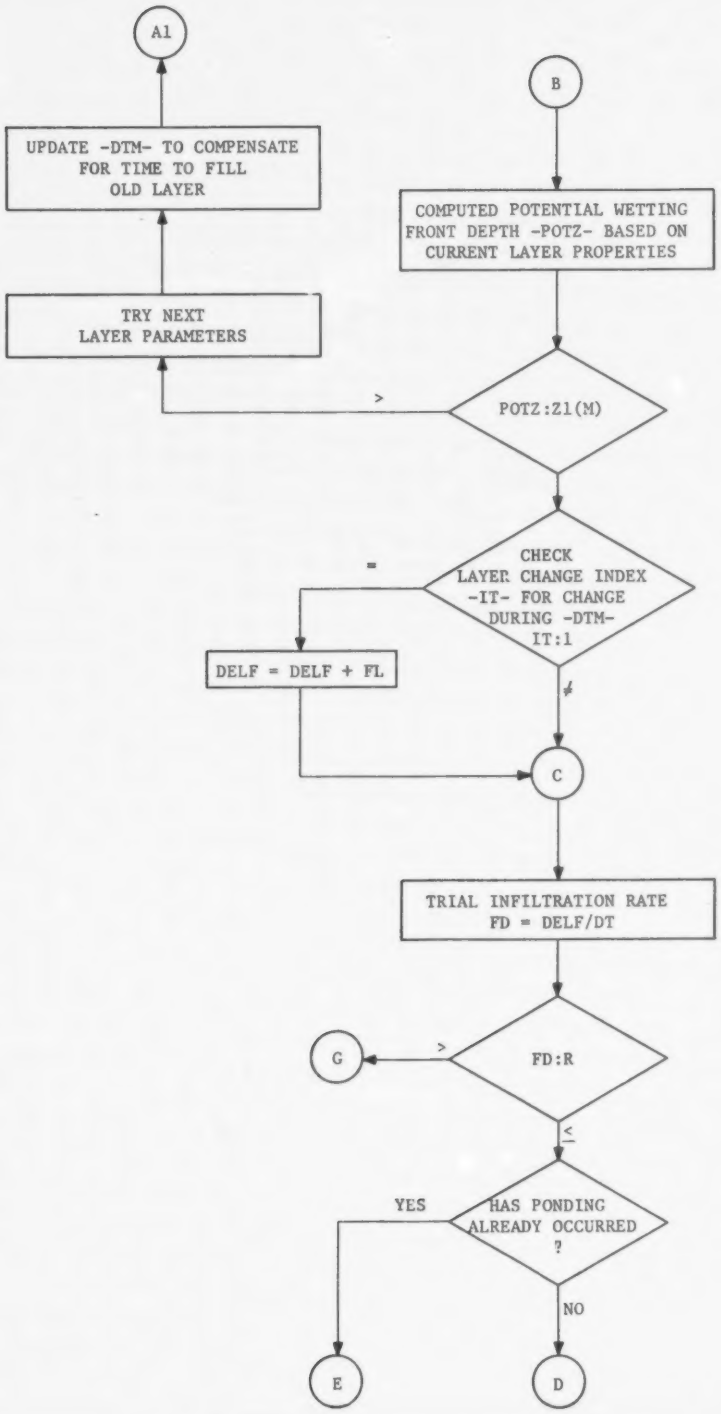
Flow chart of Subroutine INTRCP, Program HYDROL.



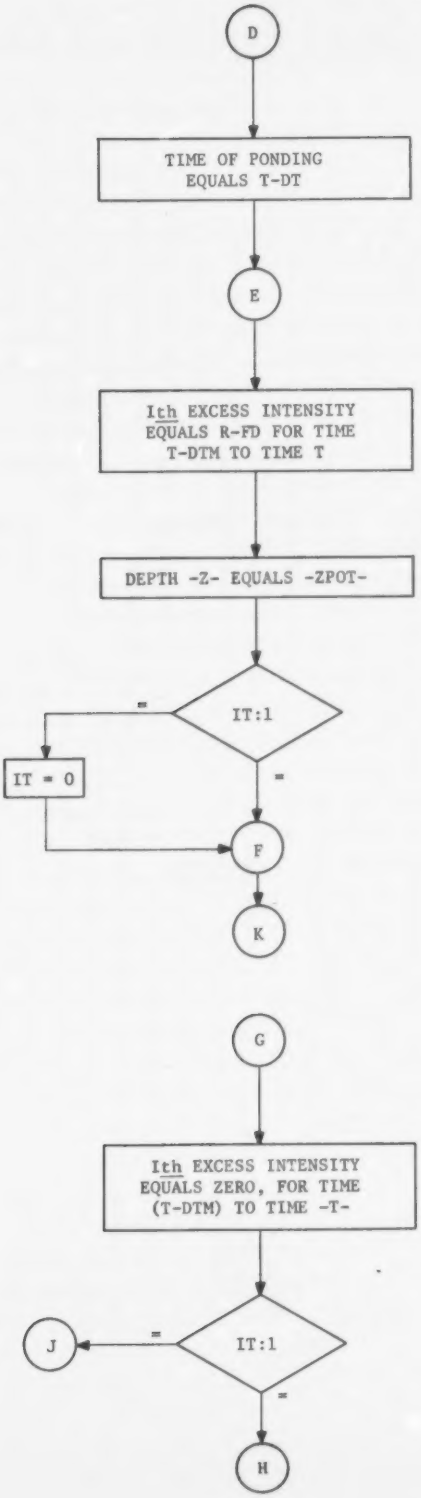
Flow chart of Subroutine INTRCP, Program HYDROL.



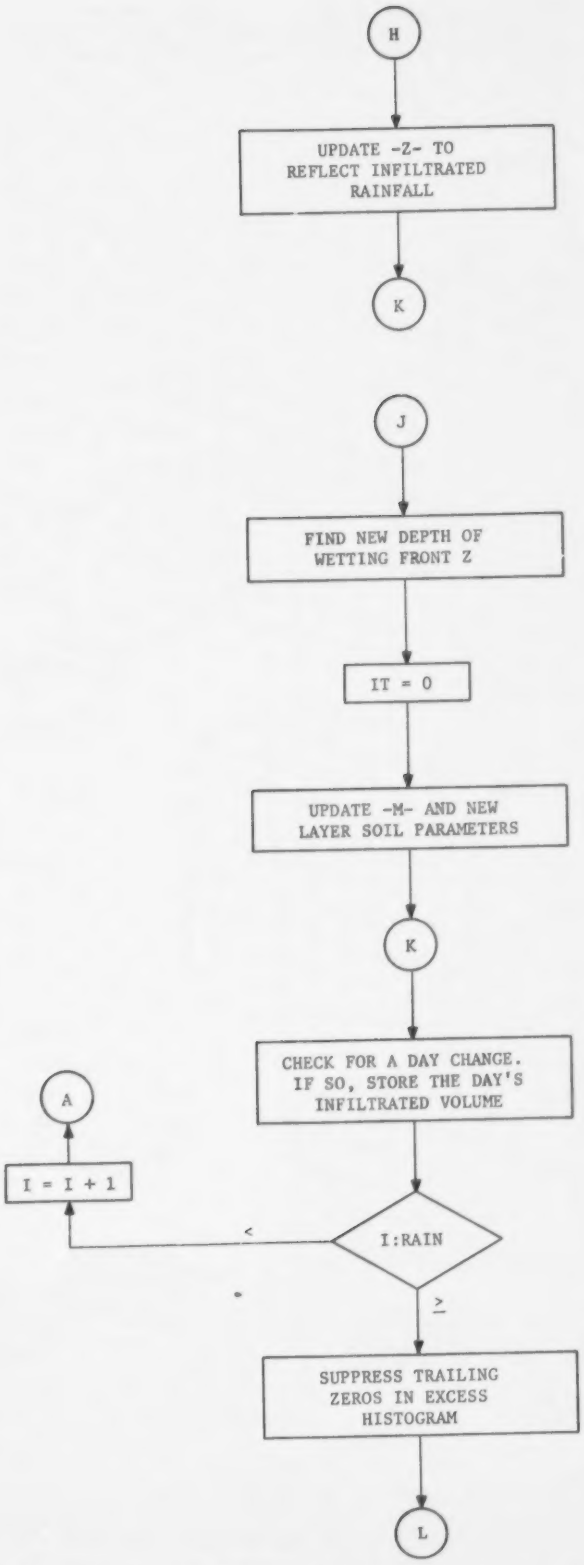
Flow chart of Subroutine LAYINF, Program HYDROL.



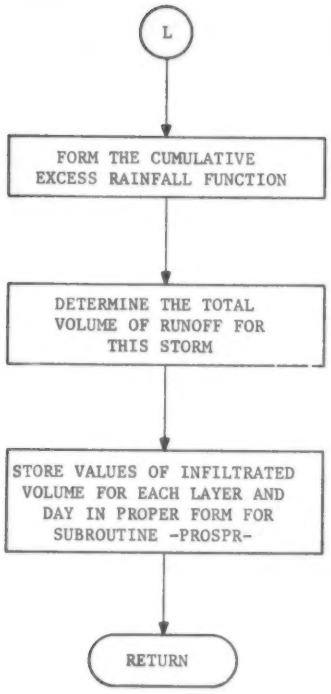
Flow chart of Subroutine LAYINF, Program HYDROL.



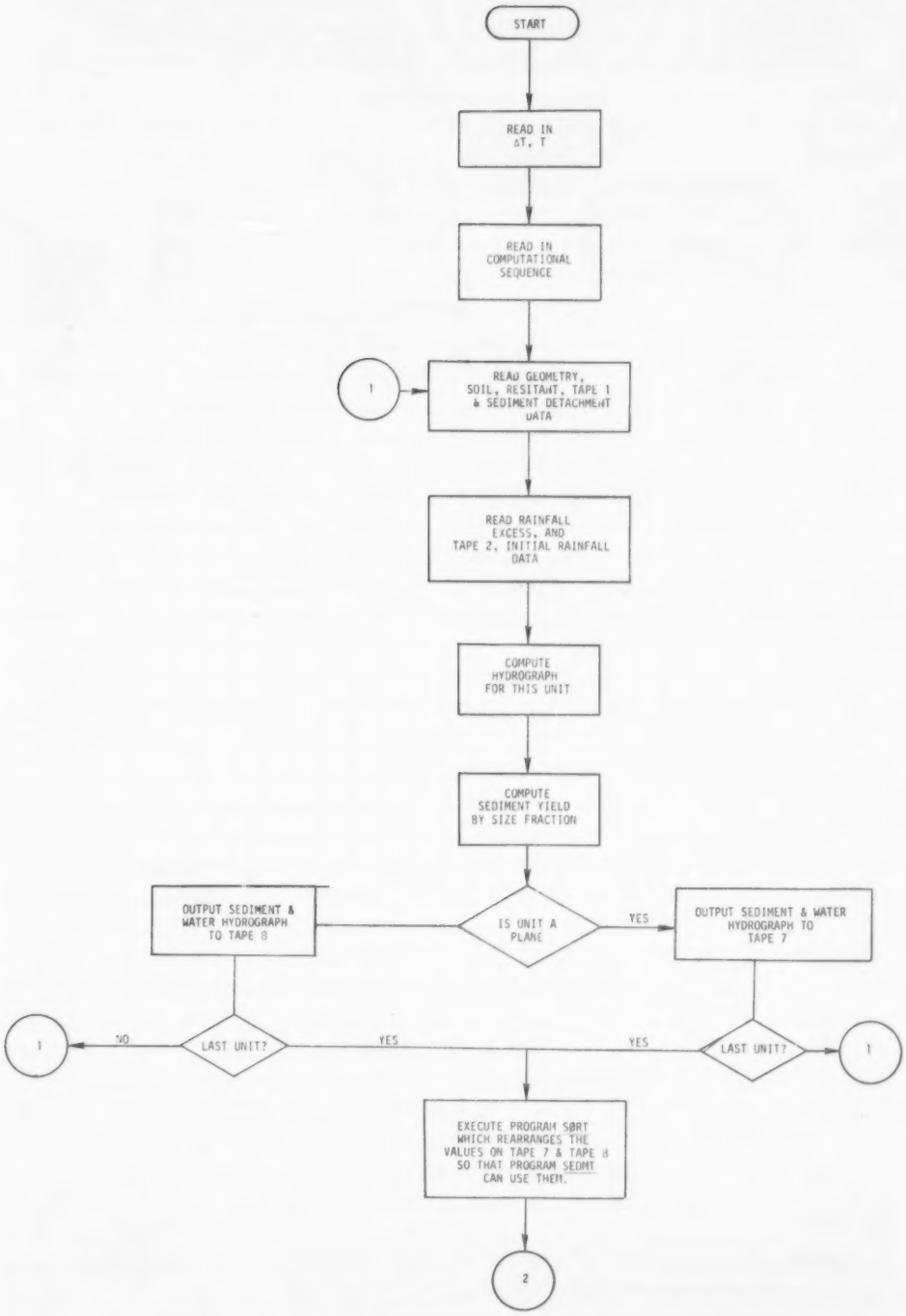
Flow chart of Subroutine LAYINF, Program HYDROL.



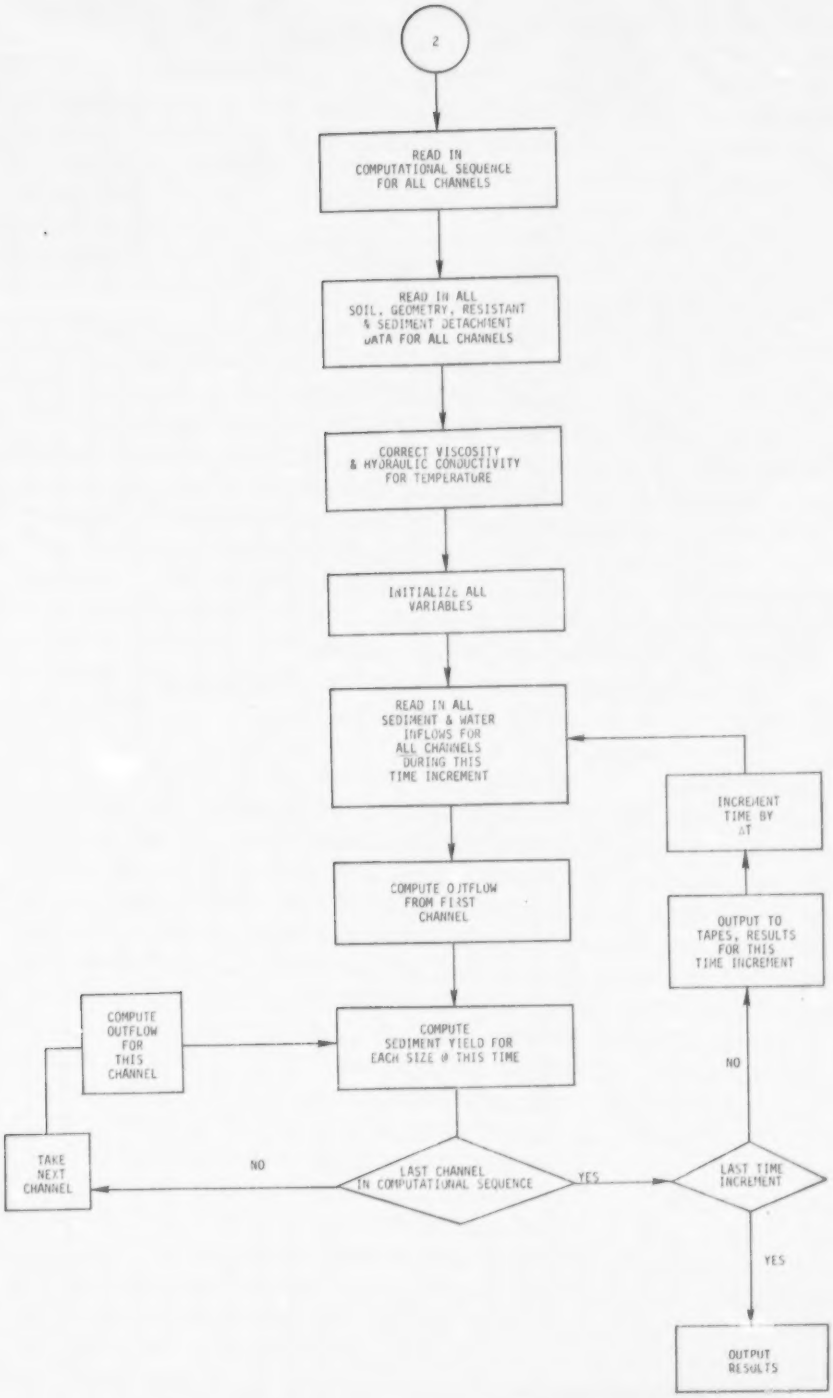
Flow chart of Subroutine LAYINF, Program HYDROL.



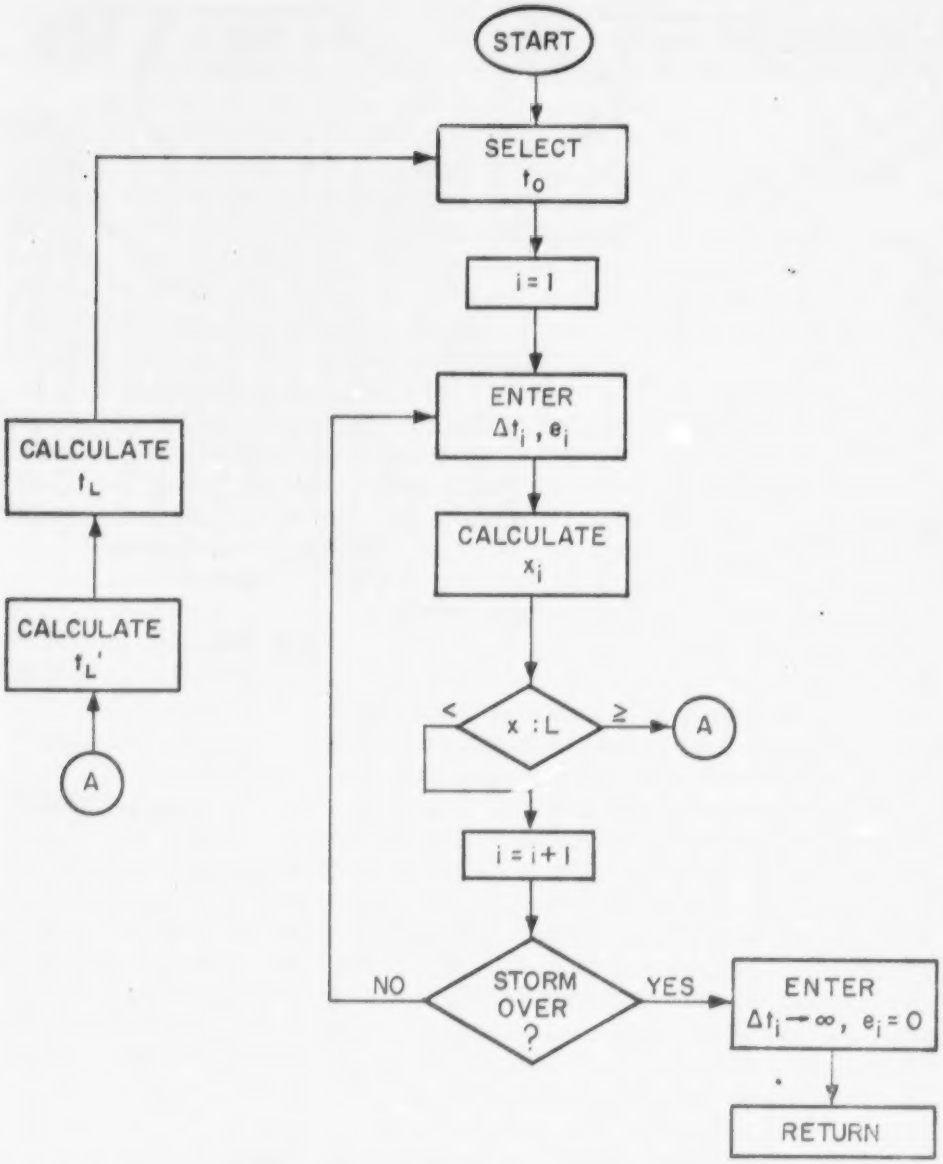
Flow chart of Subroutine LAYINF, Program HYDROL.



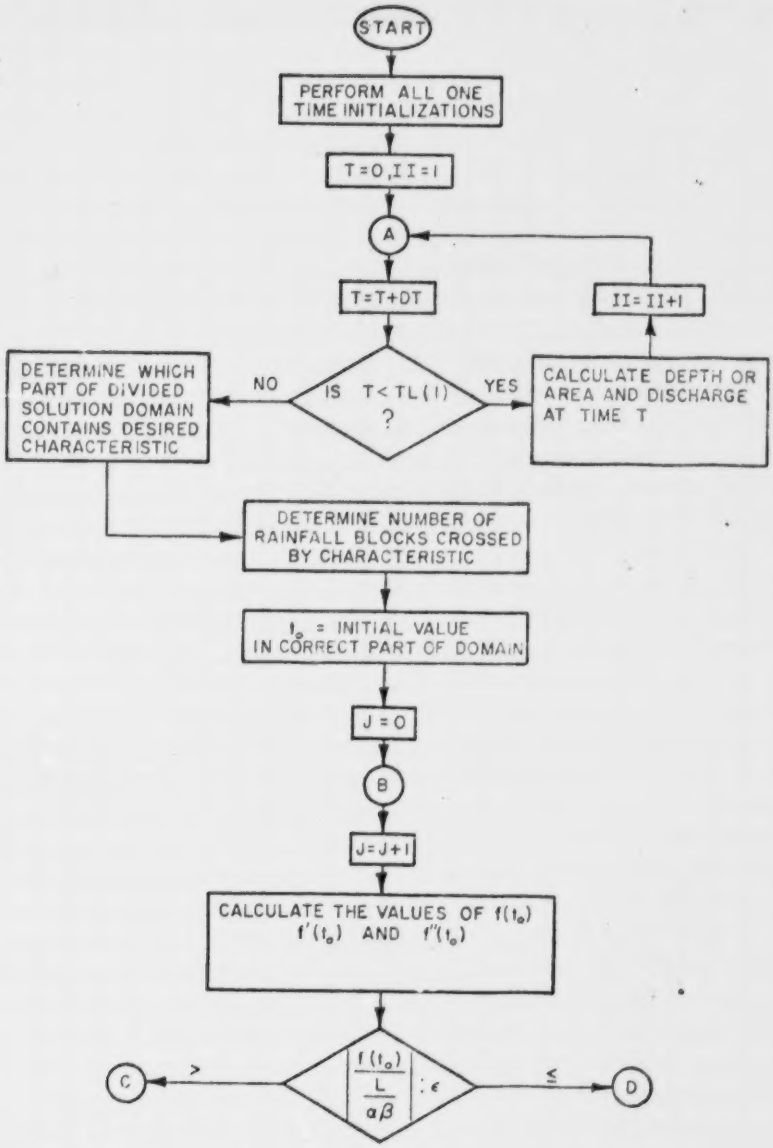
Overall flow chart for water and sediment routing. Programs: Subprogram RUNOFF.



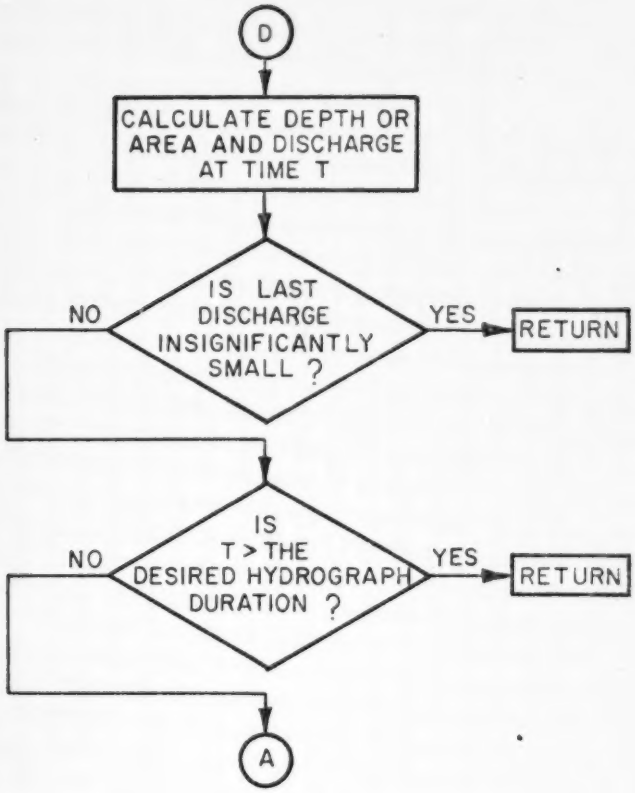
Overall flow chart for water and sediment routing. Programs: Subprogram RUNOFF.



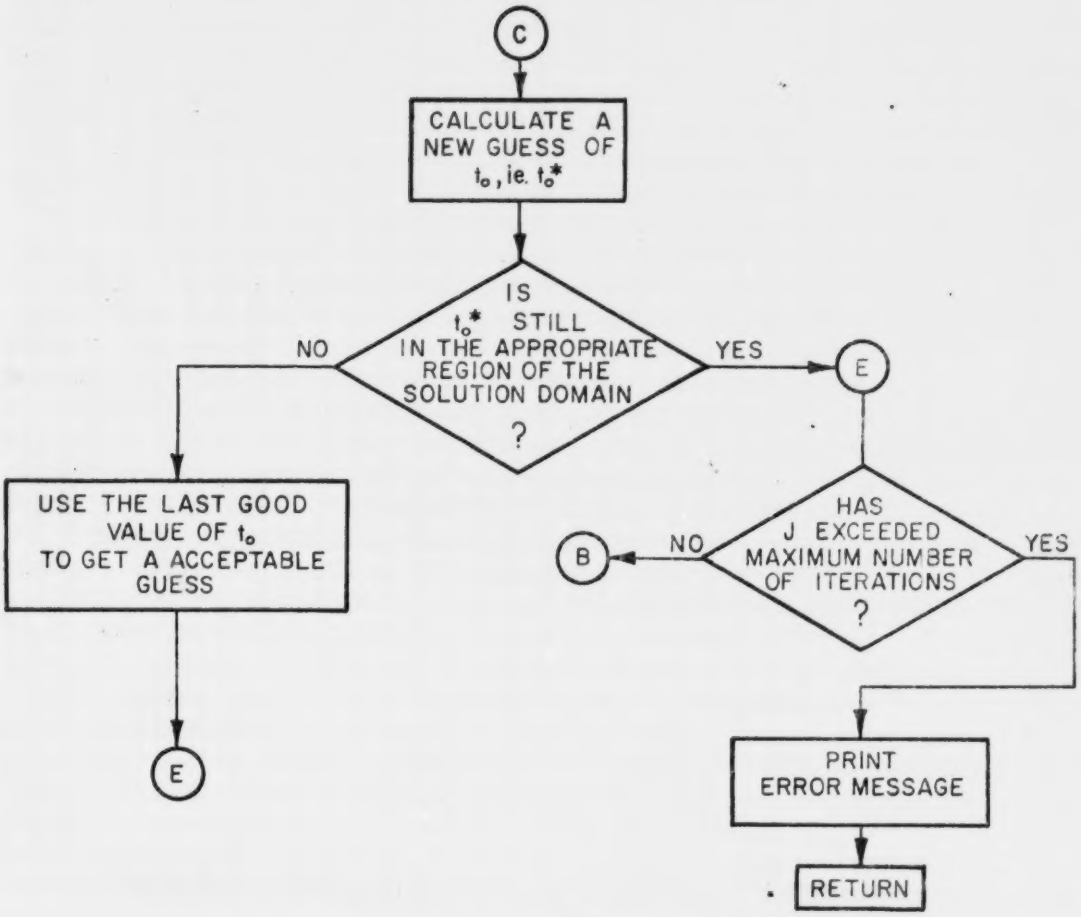
Flow chart of Subroutine FORWARD, Program HYDROL.



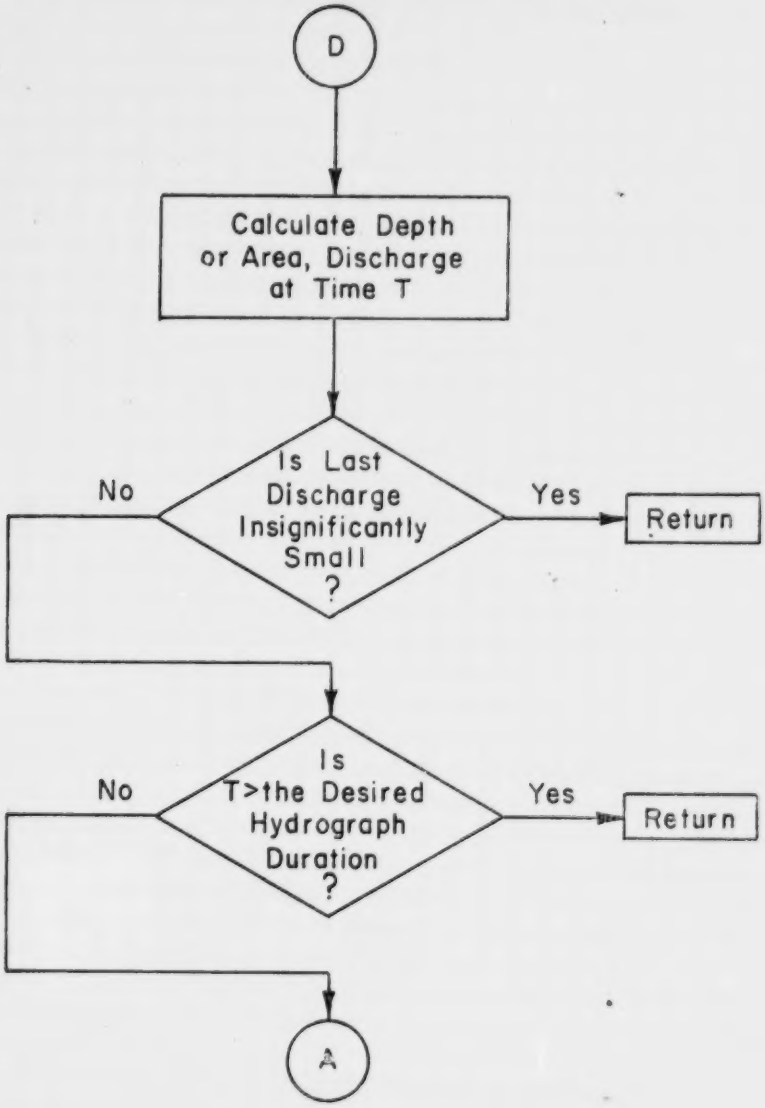
Flow chart of Subroutine BACK, Program MULT.



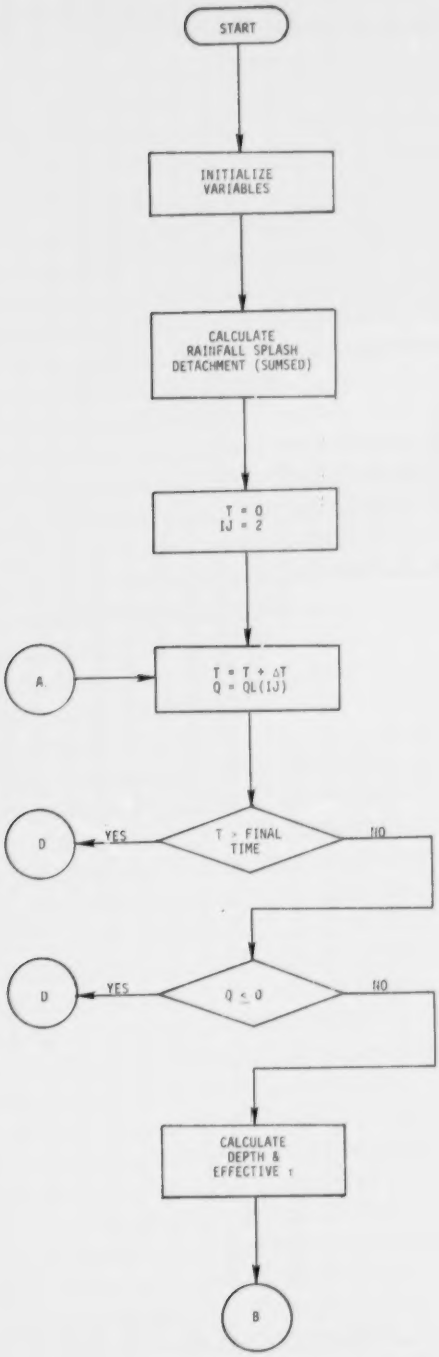
Flow chart of Subroutine BACK, Program MULT.



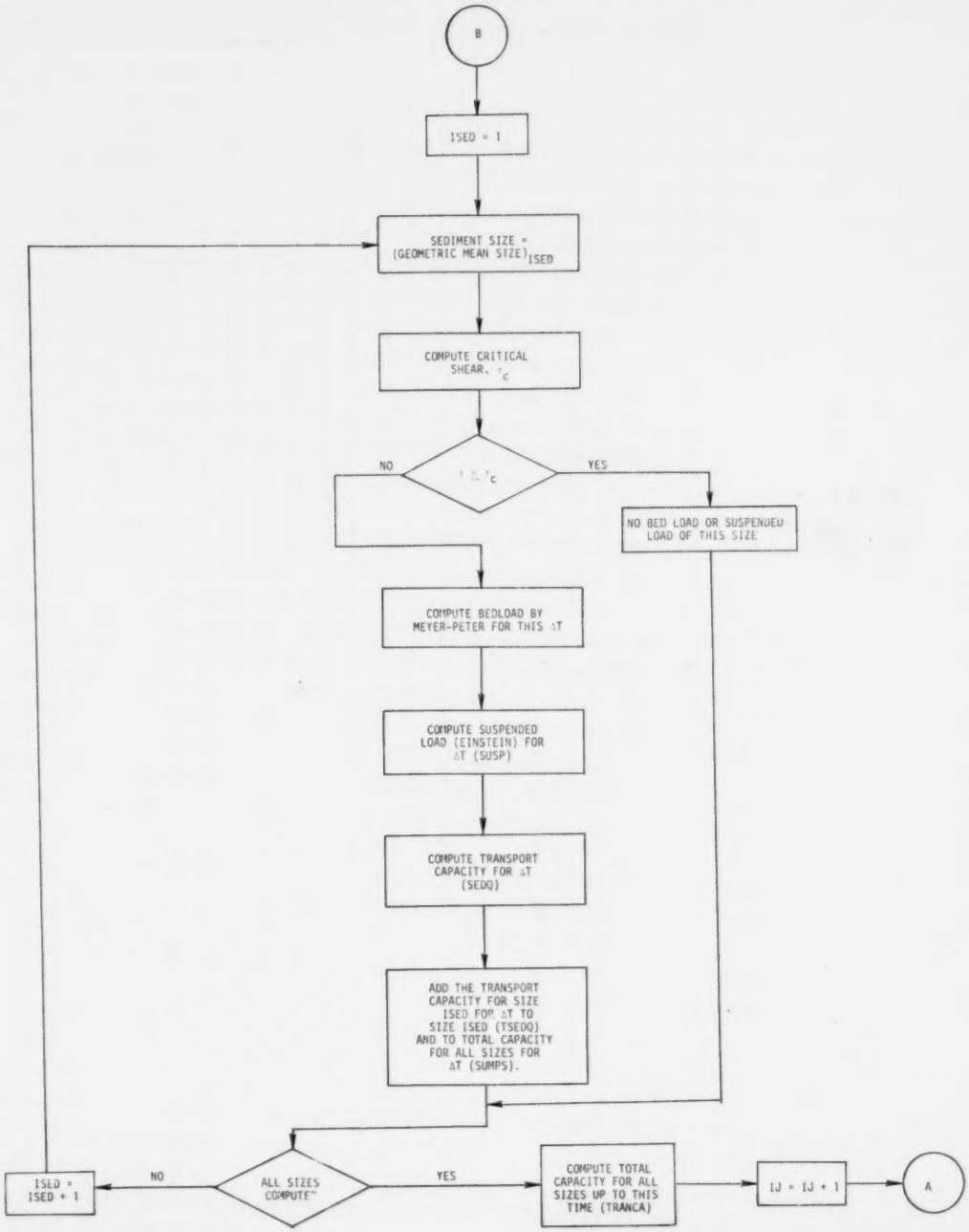
Flow chart of Subroutine BACK, Program MULT.



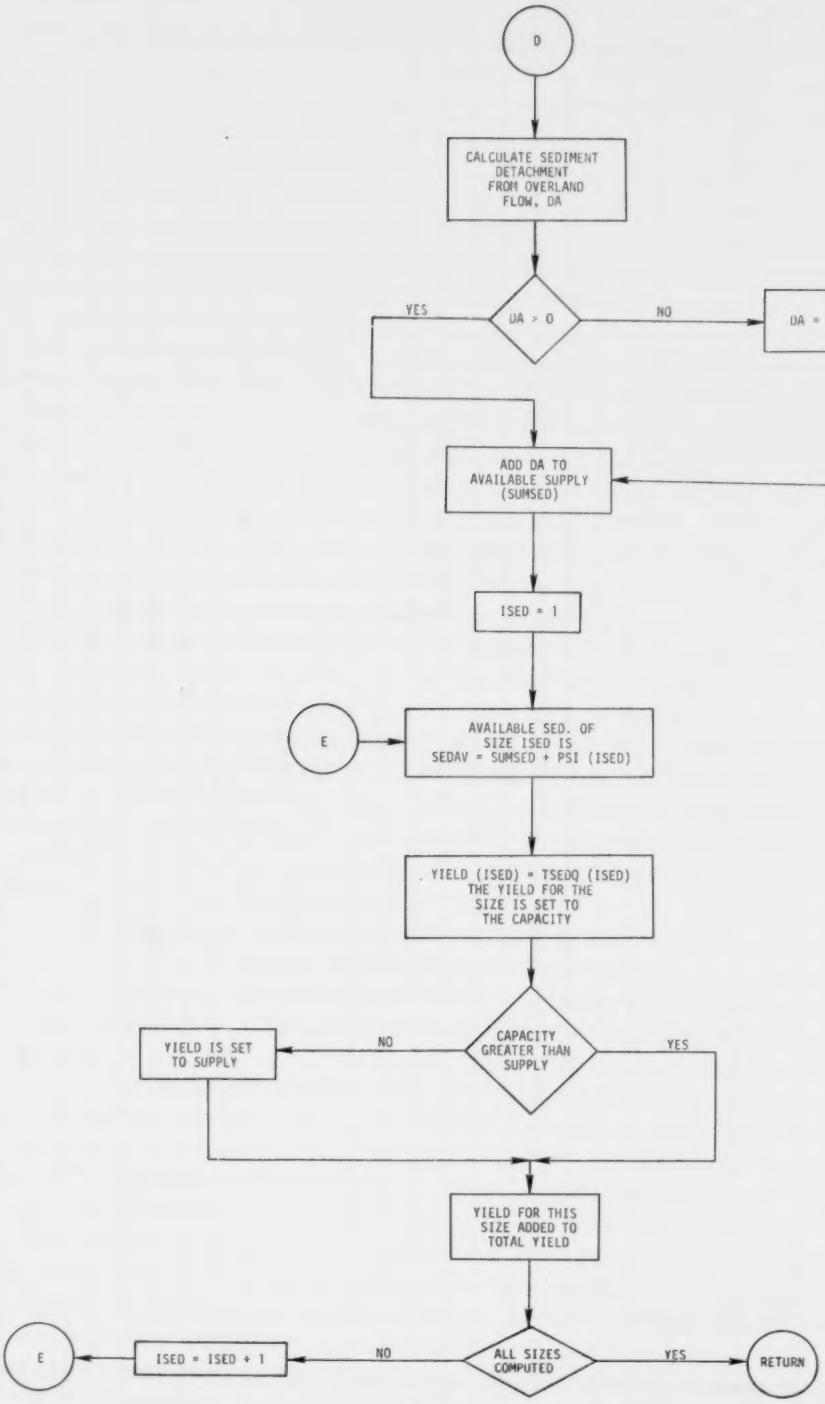
Flow chart of Subroutine BACK, Program MULT.



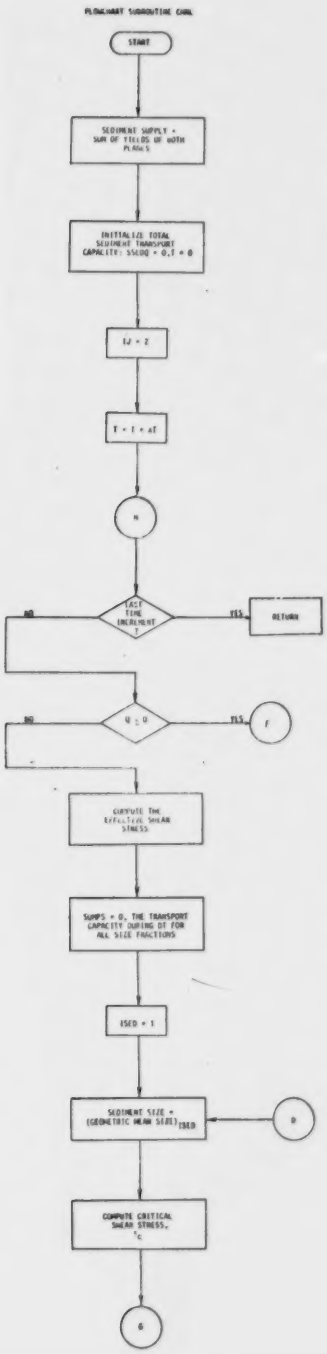
Flow chart of Subroutine PLANE, Program MULT.



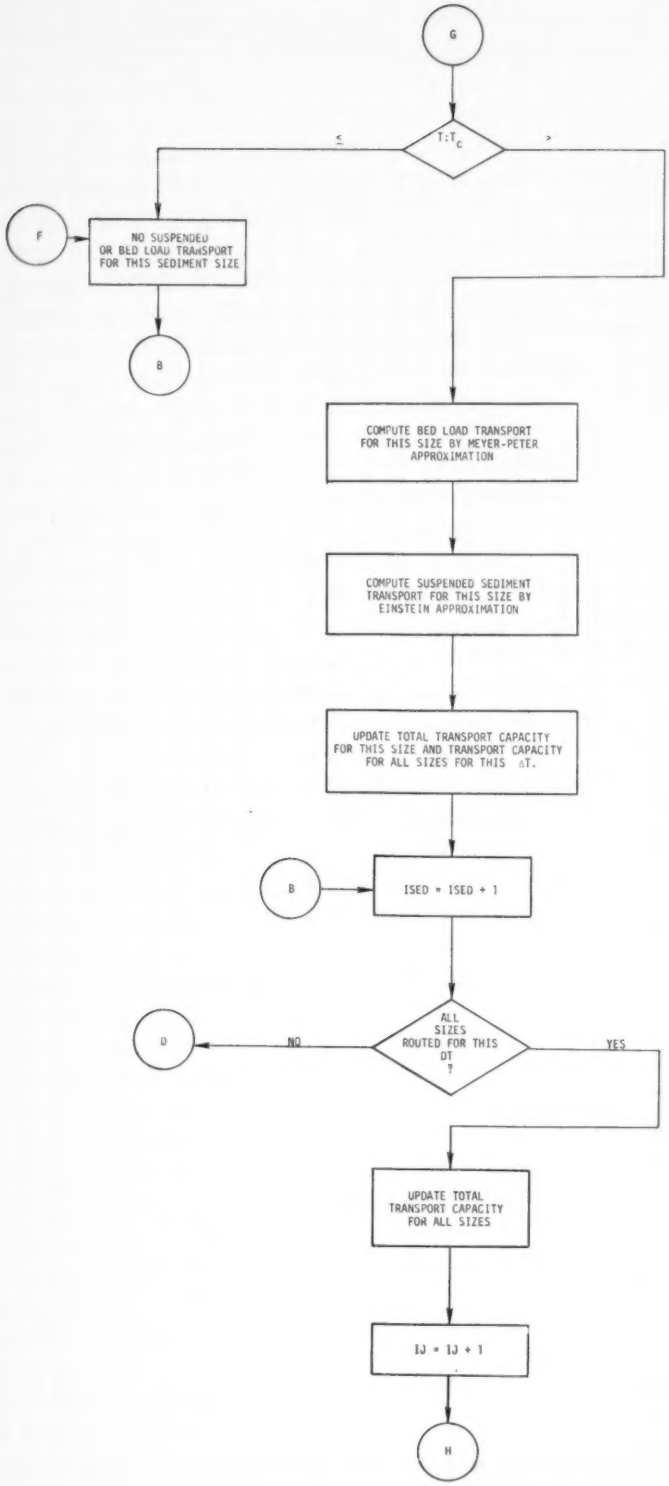
Flow chart for Subroutine PLANE, Program MULT.



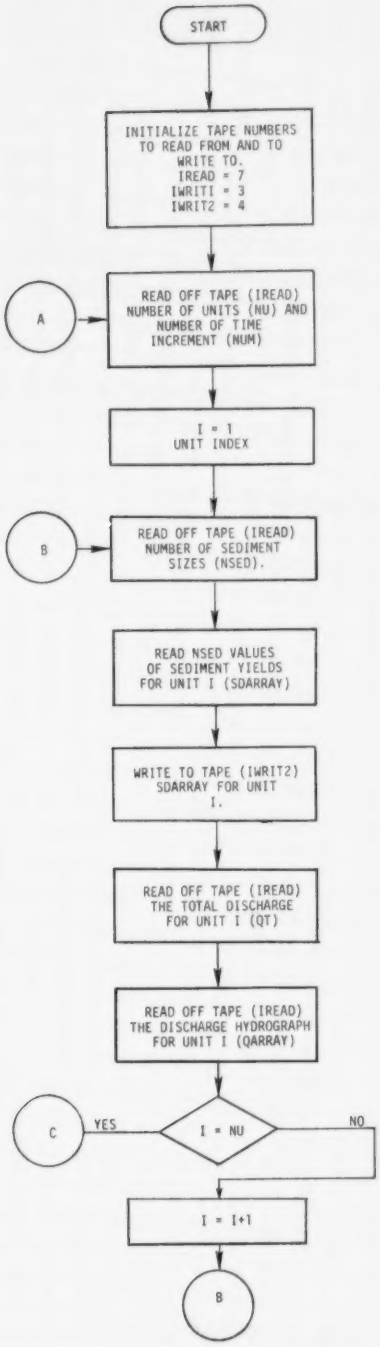
Flow chart for Subroutine PLANE, Program MULT.



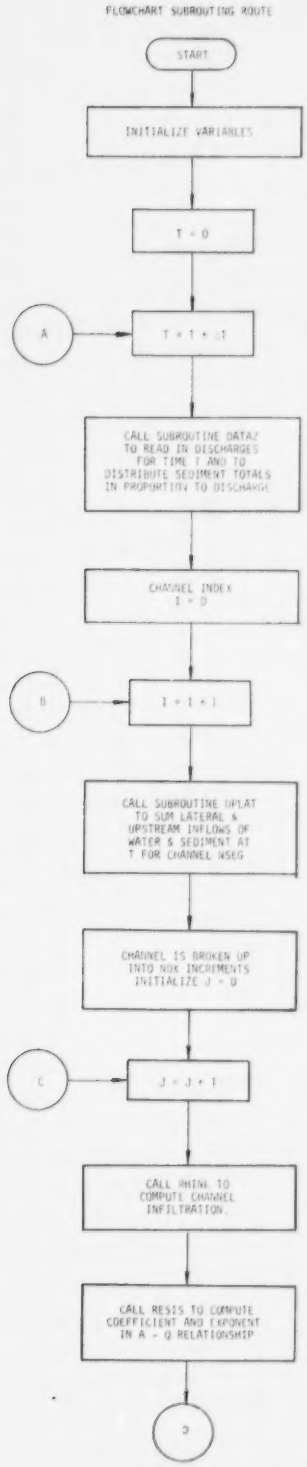
Flow chart for Subroutine CHNL, Program MULT.



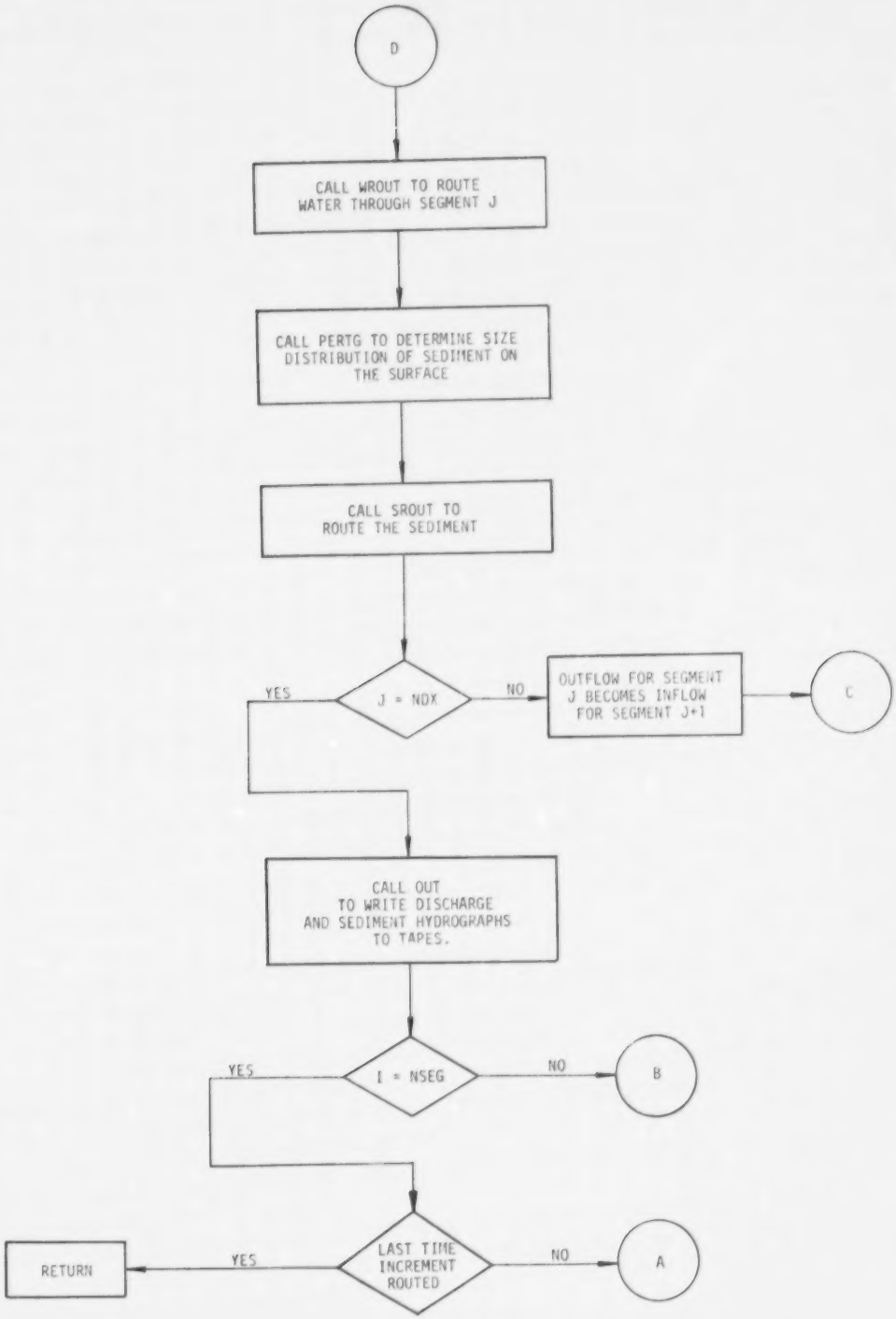
Flow chart for Subroutine CHNL, Program MULT.



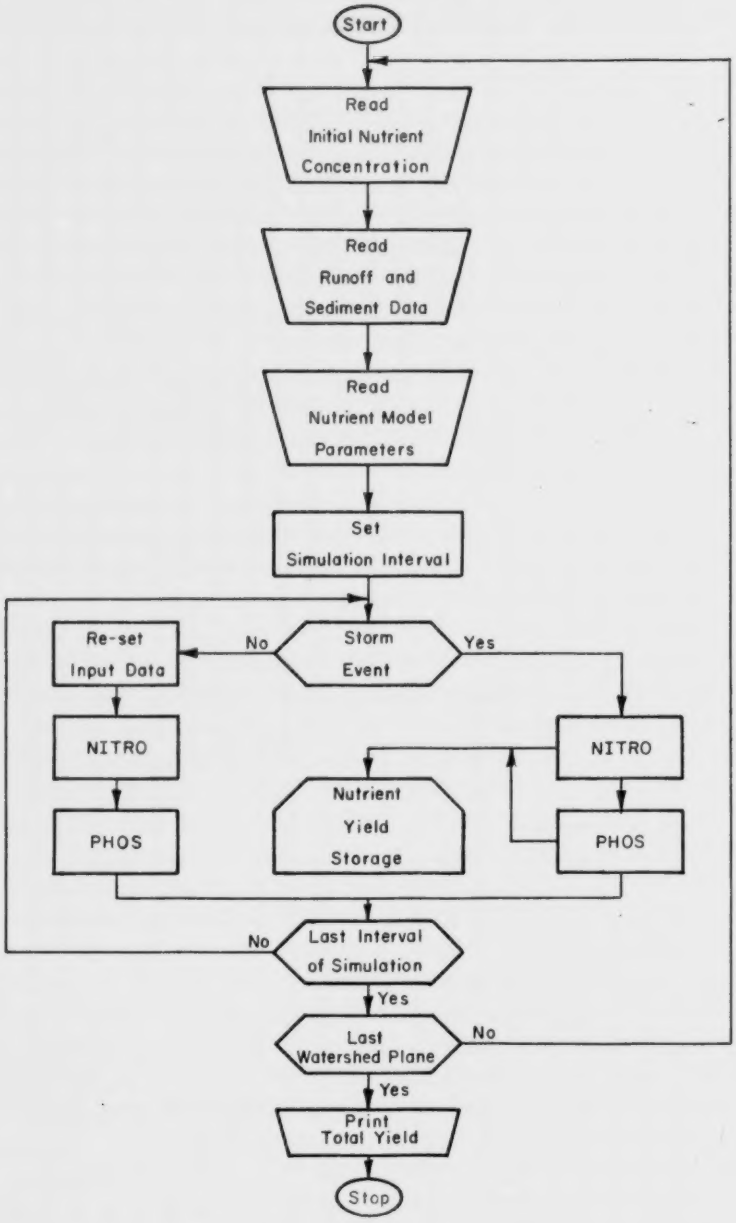
Flow chart for Program USFSORT.



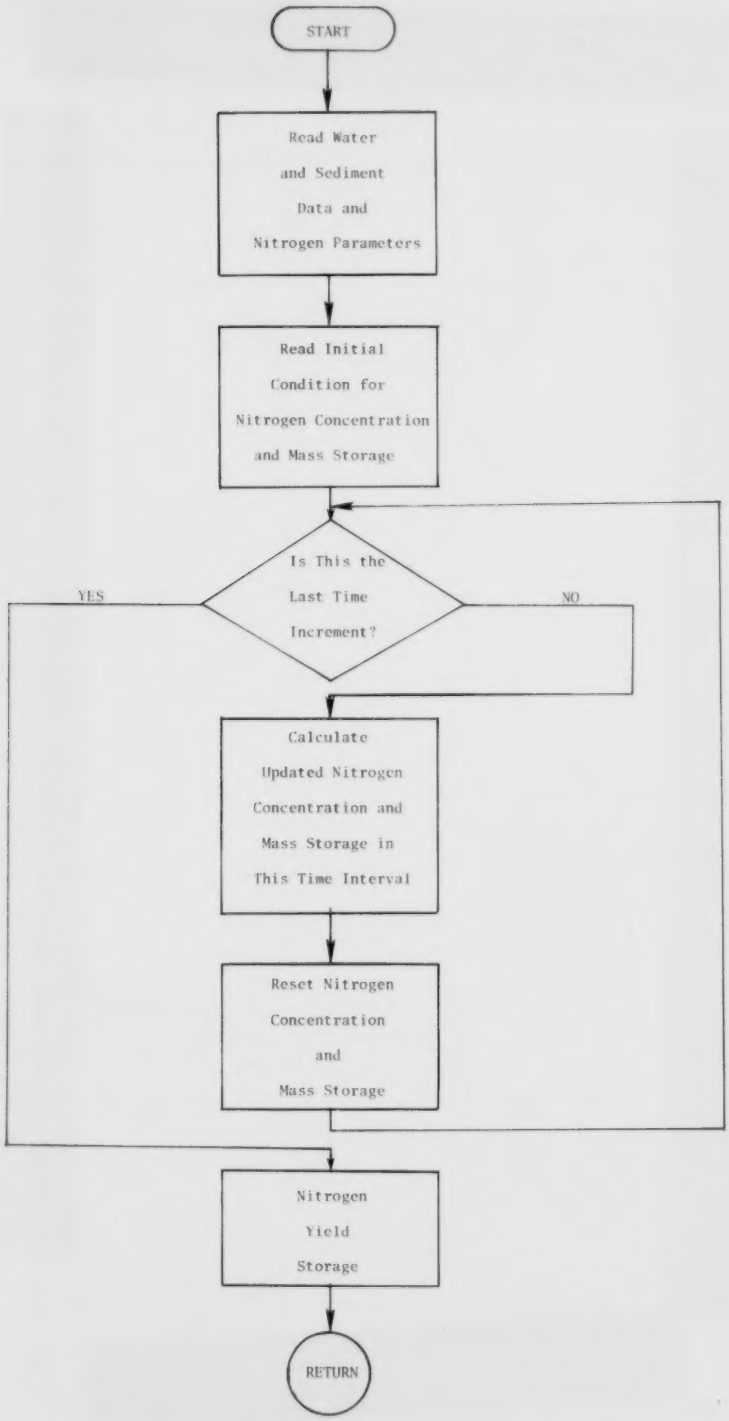
Flow chart for Subroutine ROUTE, Program MCHNL.



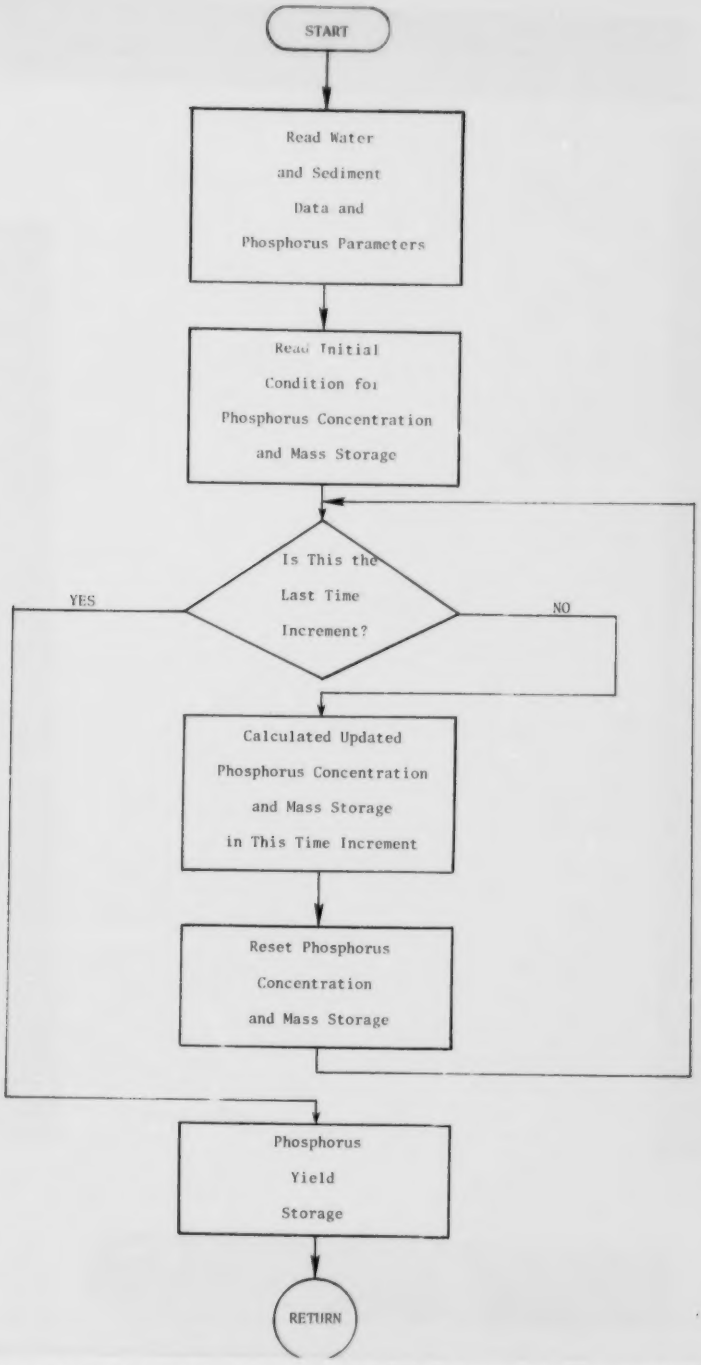
Flow chart for Subroutine ROUTE, Program MCHNL.



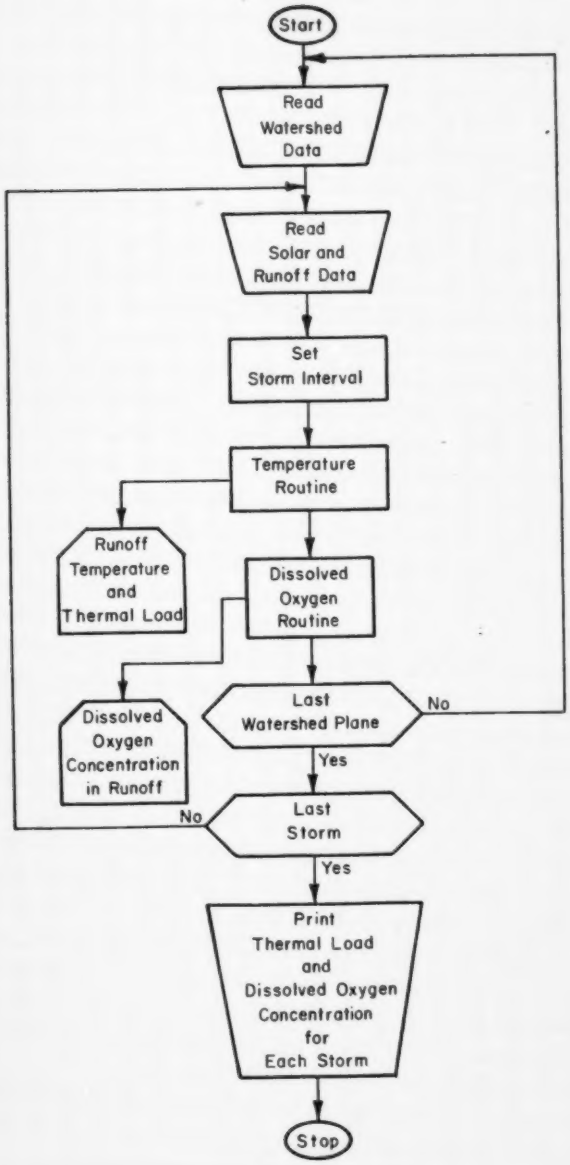
Flow chart for nutrient model, Program NUTRINT.



Flow chart of nitrogen cycle calculation, Program NUTRINT.

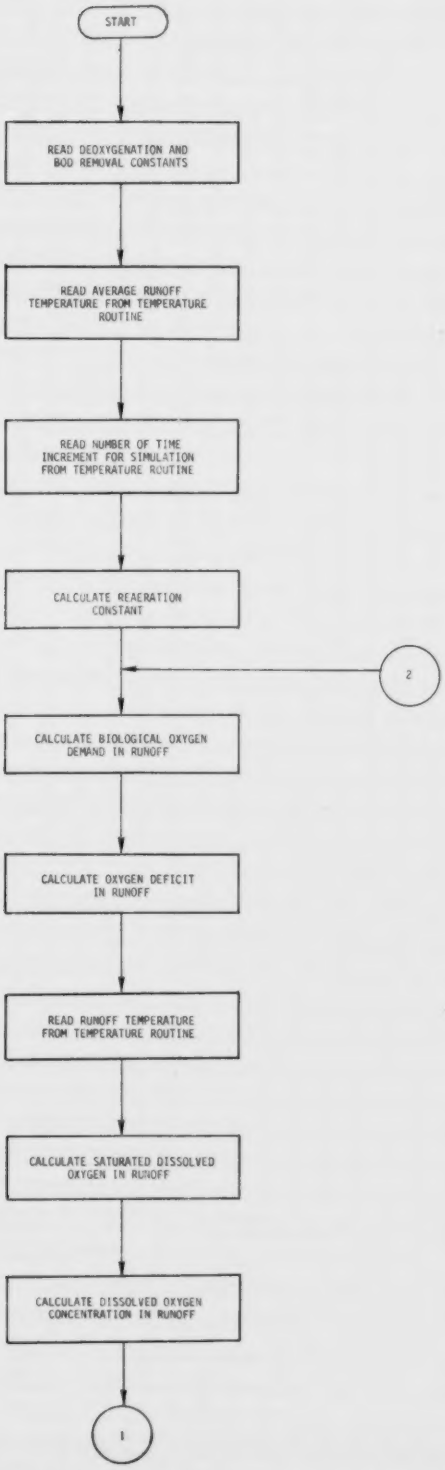


Flow chart for phosphorus cycle calculation, Program NUTRINT.



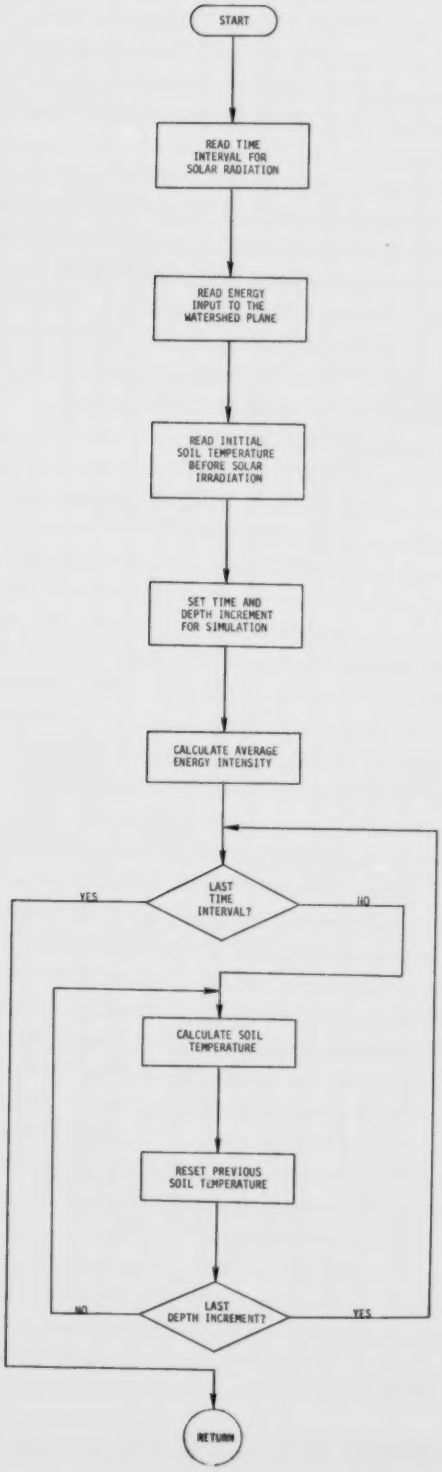
Flow chart for dissolved oxygen - temperature routing model, Program OXTEMP.

DISSOLVED OXYGEN ROUTINE

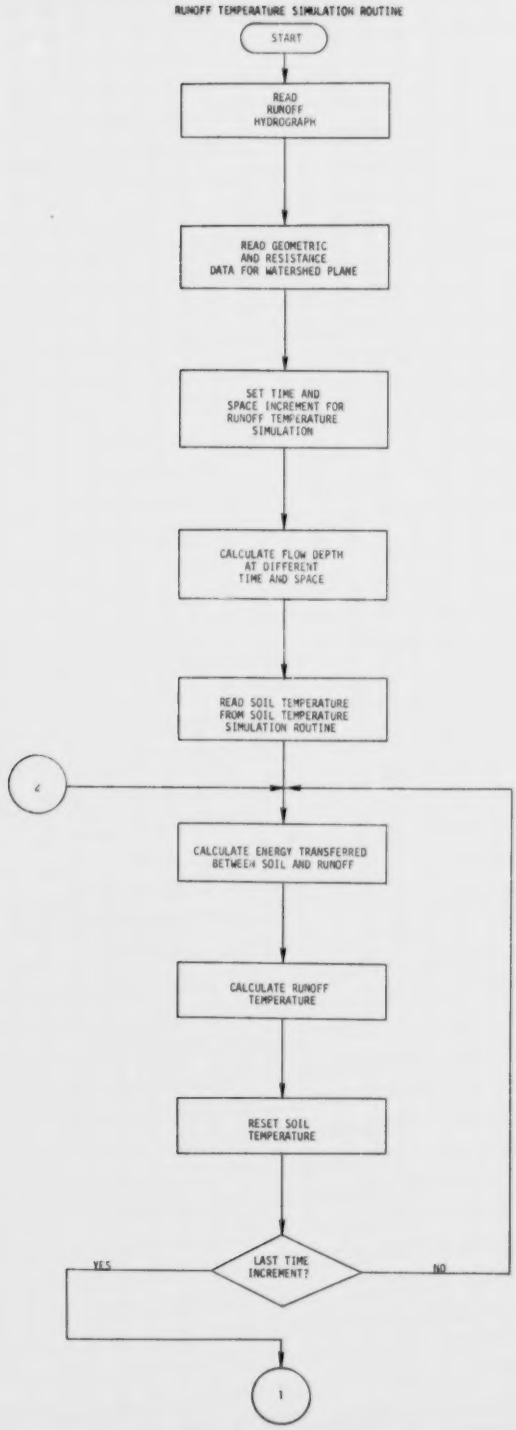


Flow chart for dissolved oxygen calculation, Program OXTEMP.

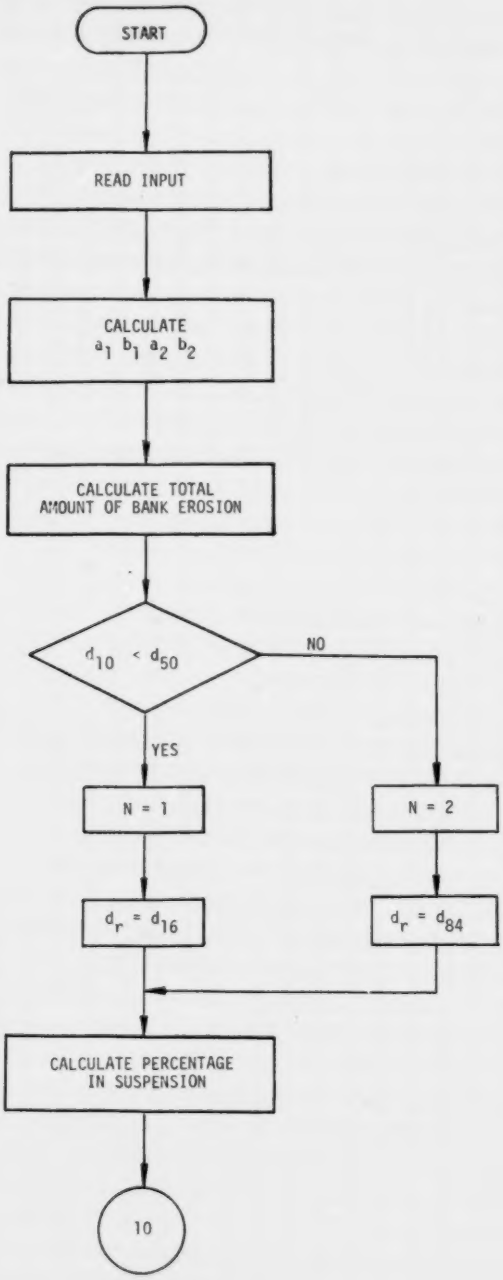
SOIL TEMPERATURE SIMULATION ROUTINE



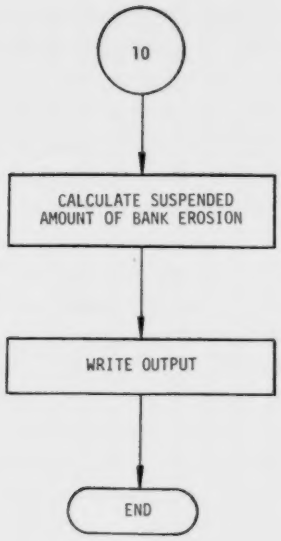
Flow chart of soil temperature calculation, Program OXTEMP.



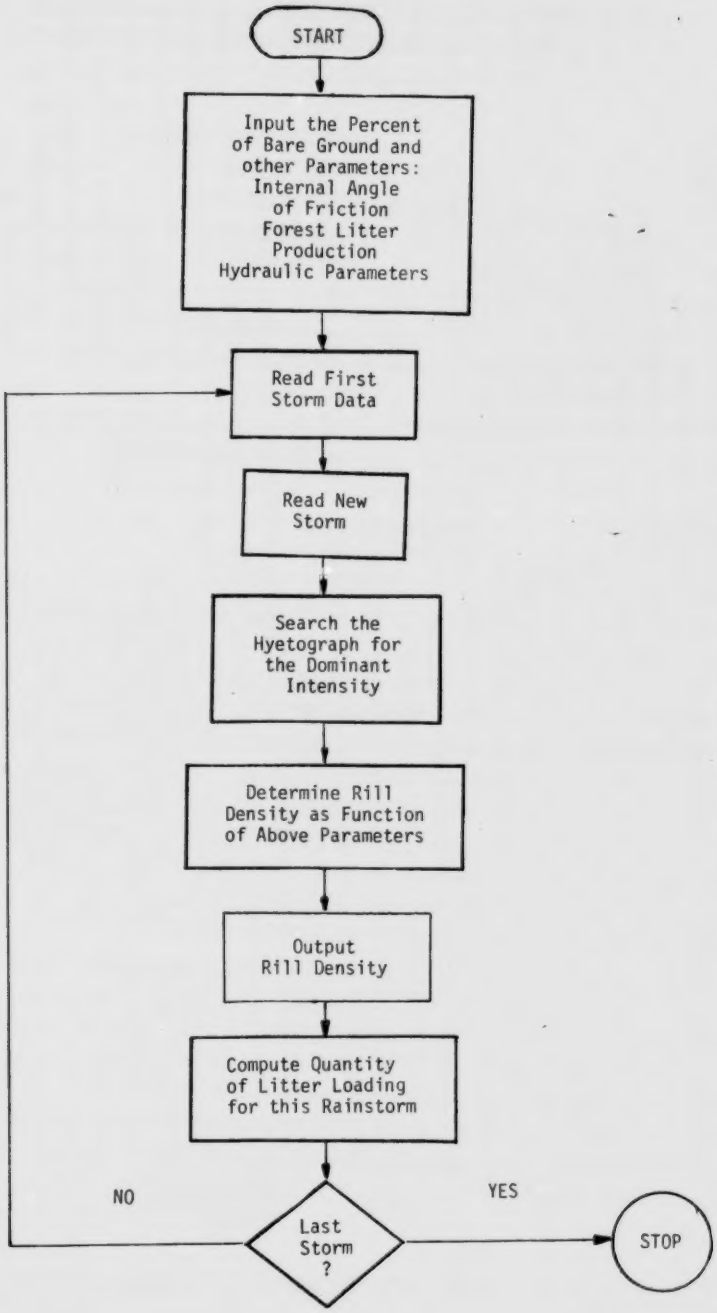
Flow chart of runoff temperature calculation, Program OXTEMP.



Flow chart of Program SBEROS.



Flow chart of Program SBEROS.



Flow chart of Program RILL.